

YEAR BOOK
OF THE
American Iron and Steel Institute
1918

MAY MEETING, NEW YORK



Published by the
American Iron and Steel Institute
61 Broadway, New York

Copyright, 1919, by
AMERICAN IRON AND STEEL INSTITUTE

FOREWORD

This is the eighth Year Book of the American Iron and Steel Institute.

The first Year Book gave the proceedings of the International meeting which began in New York on Friday, October 14, 1910, and was continued in Buffalo, Chicago, Pittsburgh and Washington.

In 1911 the Institute held no general meetings.

The second Year Book gave the proceedings of the two general meetings held in 1912, the May meeting in New York and the October meeting in Pittsburgh.

The third Year Book gave the proceedings of the two general meetings held in 1913, the May meeting in New York and the October meeting in Chicago.

The fourth Year Book gave the proceedings of the two general meetings held in 1914, the May meeting in New York and the October meeting in Birmingham.

The fifth Year Book gave the proceedings of the two general meetings held in 1915, the May meeting in New York and the October meeting in Cleveland.

The sixth Year Book gave the proceedings of the two general meetings held in 1916, the May meeting in New York and the October meeting in St. Louis.

The seventh Year Book gave the proceedings of the two general meetings held in 1917, the May meeting in New York and the October meeting in Cincinnati.

The present volume contains the proceedings of the general meeting held in May, 1918, in New York. On account of the war no October meeting was held.

JAMES T. McCLEARY,
Secretary.

TABLE OF CONTENTS

MAY MEETING

	PAGE
Program	12
Address of the President	13
The Conservation of Manganese, C. R. Ellicott and L. B. Lindemuth	25
Discussion by A. N. Diehl	38
Discussion by George B. Waterhouse	44
Discussion by J. W. Richards	48
The Principal Changes in Blast Furnace Lines During the Past Ten Years, James G. West, Jr.	50
Discussion by George L. Collord	102
Discussion by J. Stanford Fraser	105
Discussion by Walther Mathesius	109
The Triplex Process of Producing Electric Steel at South Chicago, Theodore W. Robinson	115
Discussion by Henry M. Howe	141
Discussion by John A. Mathews	143
Americanization, H. H. Wheaton	147
Relation of the Trade Papers to the Iron and Steel Industry, Bertram S. Stephenson	151
Discussion by A. O. Backert	161
Discussion by John A. Penton	167
Discussion by James R. Mills	170
Effect of Phosphorus in Soft Acid and Basic Open Hearth Steels, John S. Unger	172
Discussion by Bradley Stoughton	194
Our By-Product Coke Oven Industry in the War, William Hutton Blauvelt	197
Discussion by William A. Forbes	203
Remarks by J. Leonard Replogle	208
Remarks by Charles M. Schwab	216
Remarks by John J. Fitzgerald	224
Remarks by Major-General Glenn	231
Prolonging the Lives of Busy Men, Thomas Darlington	236

AMERICAN IRON AND STEEL INSTITUTE

OFFICERS

ELBERT H. GARY.....	President
POWELL STACKHOUSE.....	First Vice-President
WILLIS L. KING.....	Second Vice-President
CHARLES M. SCHWAB.....	Third Vice-President
EDWARD BAILEY.....	Treasurer
JAMES T. MCCLEARY.....	Secretary

DIRECTORS

Term expires 1919.

EDWARD BAILEY, Harrisburg, Pa.
JOSEPH G. BUTLER, JR., Youngstown, Ohio.
EDMUND A. S. CLARKE, New York, N. Y.
WILLIAM H. DONNER, Philadelphia, Pa.
WILLIS L. KING, Pittsburgh, Pa.
SAMUEL MATHER, Cleveland, Ohio.
JOHN A. TOPPING, New York, N. Y.

Term expires 1920.

LEOPOLD E. BLOCK, Chicago, Ill.
ALVA C. DINKEY, Philadelphia, Pa.
JAMES A. FARRELL, New York, N. Y.
ELBERT H. GARY, New York, N. Y.
ROBERT HOBSON, Hamilton, Canada.
CHARLES M. SCHWAB, New York, N. Y.
POWELL STACKHOUSE, Philadelphia, Pa.

Term expires 1921.

JAMES A. BURDEN, Troy, N. Y.
JAMES A. CAMPBELL, Youngstown, Ohio.
THOMAS CANTLEY, New Glasgow, Nova Scotia.
THOMAS GLENN, Atlanta, Georgia.
EUGENE G. GRACE, South Bethlehem, Pa.
WILLIAM A. ROGERS, Buffalo, N. Y.
JESSE F. WELBORN, Denver, Colorado.

STANDING COMMITTEES

Committee on Membership

ELBERT H. GARY, *Chairman*

JAMES A. BURDEN	SAMUEL MATHER
E. A. S. CLARKE	CHARLES M. SCHWAB
JAMES A. FARRELL	POWELL STACKHOUSE
WILLIS L. KING	JOHN A. TOPPING

Committee on Welfare Work

ELBERT H. GARY, *Chairman*

E. A. S. CLARKE	WILLIAM B. SCHILLER
GEORGE G. CRAWFORD	JOHN A. TOPPING
JAMES A. FARRELL	FREDERICK W. WOOD

Committee on Improvement in Methods

ELBERT H. GARY, *Chairman*

JAMES A. CAMPBELL	WILLIS L. KING
E. A. S. CLARKE	SAMUEL MATHER
ALVA C. DINKEY	WILLIAM A. ROGERS
EUGENE G. GRACE	CHARLES M. SCHWAB

Committee on Foreign Relations

ELBERT H. GARY, *Chairman*

E. A. S. CLARKE	CHARLES M. SCHWAB
JAMES A. FARRELL	FREDERICK W. WOOD

SPECIAL COMMITTEES

Committee on Publications

ELBERT H. GARY, *Chairman*

E. A. S. CLARKE	JAMES A. FARRELL
-----------------	------------------

Committee on Contract Obligations

WILLIS L. KING, *Chairman*

JAMES A. CAMPBELL	WILLIAM H. DONNER
E. A. S. CLARKE	JAMES A. FARRELL
JOHN A. TOPPING	

General Committee on Arrangements

May Meeting

JAMES A. FARRELL, *Chairman*

JAMES A. BURDEN	CHARLES M. SCHWAB
E. A. S. CLARKE	JOHN A. TOPPING

WAR-WORK COMMITTEE AND SUB-COMMITTEES

Committee on Steel and Steel Products

ELBERT H. GARY, *Chairman*

J. A. FARRELL, *Vice-Chairman* E. A. S. CLARKE, *Secretary*

L. E. BLOCK E. G. GRACE

J. A. BURDEN A. F. HUSTON

J. A. CAMPBELL W. L. KING

H. G. DALTON C. M. SCHWAB

A. C. DINKEY J. A. TOPPING

H. H. COOK, *Assistant Secretary*

Sub-Committee on Price Recommendations

JAMES A. FARRELL, *Chairman*

E. A. S. CLARKE, *Secretary* E. G. GRACE

A. C. DINKEY J. A. TOPPING

Sub-Committee on Steel Distribution

JAMES A. FARRELL, *Chairman*

J. B. BONNER F. J. HALL

O. P. BLAKE W. L. HOFFMAN

E. A. S. CLARKE H. F. HOLLOWAY

J. A. TOPPING

Sub-Committee on Ferro-Alloys

JAMES A. FARRELL, *Chairman*

A. A. FOWLER, *Secretary* E. J. LAVINO

C. A. BUCK A. D. LEDOUX

E. A. S. CLARKE E. F. PRICE

D. G. KERR FRANK SAMUEL

F. W. WHITE

**Sub-Committee on Pig Iron, Iron Ore and Lake
Transportation**

HARRY G. DALTON, *Chairman*

A. S. MATHER, <i>Secretary</i>	LEONARD PICKITT
FRANK BILLINGS	FRANK B. RICHARDS
H. COULBY	W. T. SHEPARD
C. D. DYER	A. H. WOODWARD
HORACE S. WILKINSON	

Sub-Committee on Tubular Products

JAMES A. CAMPBELL, *Chairman*

H. A. BEALE, JR.	G. MATHESON, JR.
L. M. JOHNSON	W. H. ROWE
ANSON MARK	E. WORCESTER

Sub-Committee on Sheet Steel

WILLIAM S. HORNER, *Chairman*

WALTER C. CARROLL	CHARLES O. HADLEY
-------------------	-------------------

Sub-Committee on Tin Plate

JAY I. ANDREWS, *Chairman*

E. R. CRAWFORD	E. T. WEIR
----------------	------------

Sub-Committee on Pig Tin

JOHN HUGHES, *Chairman*

E. R. CRAWFORD	JOHN A. FRYE
G. D. DORSEY	

Sub-Committee on Scrap Iron and Steel

W. VERNON PHILLIPS, *Chairman*

C. A. BARNES, <i>Secretary</i>	J. MICHAELS
J. C. BROWN	T. E. MORITZ
C. DREIFUS	J. S. PENDLETON
W. C. ELY	D. C. SCHONTHAL
B. D. FULLER	E. E. SMITH
A. S. HOOK	H. B. SPACKMAN
ELI JOSEPH	RODNEY THAYER
C. E. MCKILLIPS	W. M. TOBIAS

Sub-Committee on Wire Products

FRANK BAACKES, *Chairman*

J. E. FREDERICK

JOHN C. NEALE

GEORGE A. MASON

H. SANBORN SMITH

Sub-Committee on Wire Rope

KARL G. ROEBLING, *Chairman*

FRANK BAACKES

JOHN J. BRODERICK

Sub-Committee on Cold Rolled and Cold Drawn Steel

FREDERICK N. BEEGLE, *Chairman*

E. L. PARKER

ROLAND GERRY

Sub-Committee on Malleable Castings

FRANK J. LANAHAN, *Chairman*

FREDERICK FRASER

H. F. POPE

J. C. HASWELL

F. L. SIVYER

Sub-Committee on Cast Iron Pipe

L. R. LEMOINE, *Chairman*

A. M. CAMPBELL

W. H. HULICK

Sub-Committee on Traffic Conditions

ANDREW G. YOUNG, *Chairman*

F. T. BENTLEY

W. H. HIGGINS

L. C. BIHLER

W. E. HOWES

J. A. COAKLEY

C. L. LINGO

H. C. CRAWFORD

H. R. MOORE

JOHN A. GROSS

CHARLES H. MUSE

J. L. RONEY

AMERICAN IRON AND STEEL INSTITUTE

FOURTEENTH GENERAL MEETING

New York, May 31st and June 1st, 1918

The Fourteenth General Meeting of the American Iron and Steel Institute was held at the Waldorf-Astoria Hotel, New York City, on Friday and Saturday, May 31 and June 1, 1918.

Following the usual practice, three sessions were held on Friday, all in the Grand Ball Room. The forenoon and afternoon sessions were devoted entirely to the reading and discussion of papers. The evening session included the annual dinner. As usual, the papers, discussions and addresses covered questions of metallurgy, of business and welfare work.

On Friday the Secretary had a temporary office near the Grand Ball Room, where members registered for the meeting and were provided with identification buttons and with programs.

At the noon recess on Friday the members of the Institute were its guests at a buffet luncheon. During this recess, also, the Directors held a Board Meeting.

The attendance was larger than at any other meeting thus far held.

On the next page will be found the program of the Friday sessions. Judge Gary, President of the Institute, presided during the forenoon and until the completion of Mr. Robinson's paper in the afternoon, when he was succeeded to the Chair by Vice-President Willis L. King. During the evening session Judge Gary again presided.

FORENOON SESSION, 10:00 A. M.

- Address of the President.....ELBERT H. GARY
Chairman, United States Steel Corporation, New York
- The Conservation of Manganese.....C. E. ELLIOTT AND L. B. LINDEMUTH
Superintendents of Furnaces, Bethlehem Steel Co., Bethlehem, Pa.
- Discussion.....A. N. DIEHL
Assistant to Vice-President, Carnegie Steel Company, Pittsburgh, Pa.
- Discussion.....GEO. B. WATERHOUSE
Metallurgical Engineer, Lackawanna Steel Co., Buffalo, N. Y.
- Discussion.....J. W. RICHARDS
Professor of Metallurgy, Lehigh University, South Bethlehem, Pa.
- The Principal Changes in Blast Furnace Lines During the
Past Ten Years.....JAMES G. WEST, JR.
Gen. Supt. Blast Furnaces, Jones & Laughlin Steel Co., Pittsburgh, Pa.
- Discussion.....GEO. L. COLLORD
Vice-President, The Shenango Furnace Co., Pittsburgh, Pa.
- Discussion.....J. STANFORD FRASER
Superintendent, Pittsburgh Steel Company, Pittsburgh, Pa.
- Discussion.....WALTHER MATHESIUS
Superintendent Blast Furnaces, Illinois Steel Co., South Chicago, Ill.

AFTERNOON SESSION, 2:00 P. M.

- The Triplex Process of Producing Electric Steel at
South Chicago.....THEODORE W. ROBINSON
Vice-President, Illinois Steel Company, Chicago, Ill.
- Discussion.....HENRY M. HOWE
Professor Emeritus of Metallurgy, Columbia University, New York
- Discussion.....JOHN A. MATHEWS
President, Halcomb Steel Company, Syracuse, New York
- Americanization Promoting.....H. H. WHEATON
Interior Department, Washington, D. C.
- Relation of the Trade Papers to the Iron Industry,
BERTRAM S. STEPHENSON
Resident Agent, M. A. Hanna & Co., Pittsburgh, Pa.
- Discussion.....A. O. BACKERT
Vice-President, Penton Publishing Company, Cleveland, Ohio
- Discussion.....JOHN A. PENTON
President, Penton Publishing Company, Cleveland, Ohio
- Discussion.....JAMES R. MILLS
Manager of Sales, Carnegie Steel Company, Cleveland, Ohio
- Our By-Product Coke Oven Industry in the War....WILLIAM H. BLAUVELT
Consulting Engineer, Semet-Solway Company, Syracuse, N. Y.
- Discussion.....WM. A. FORBES
Chairman, Benzol Committee, U. S. Steel Corporation, New York
- Effect of Phosphorus in Soft Acid and Basic Open Hearth
Steels.....JOHN S. UNGER
Manager, Central Research Bureau, Carnegie Steel Co., Pittsburgh, Pa.
- Discussion.....BRADLEY STOUGHTON
Secretary, American Institute of Mining Engineers, New York

EVENING SESSION, 7:00 P. M.

- Impromptu Remarks in Response to the Call of the President.
- Prolonging the Lives of Busy Men.....THOMAS DARLINGTON
Secretary, Welfare Committee, American Iron and Steel Institute, N. Y.

ADDRESS OF THE PRESIDENT

ELBERT H. GARY

Chairman, United States Steel Corporation, New York

I am here without a prepared address, even in my head. I might give some reasons, but that would not be useful.

It is a pleasure to greet so many members of the industry at this meeting, nearly eight years after the first one. Those who were present will remember that the first meeting was held in a rather small room adjacent to this, and that it was not filled. It gave promise of great results, and our expectations have been more than realized.

INTERNATIONAL MEETINGS OF THE INSTITUTE

There are incidents connected with that occasion which now seem to us rather sad. There were representatives from the iron and steel industry of all the steel producing countries. There were men from Germany and Austria, men of high type, fine character, men who were a credit to civilization, men for whom we had a great respect and who, if in the control of the affairs of their respective countries, would prevent the continuance of present war conditions.

Following and growing out of that meeting an International gathering was held at Brussels in 1911, attended by many who are present here today, and by a large number of representatives of the iron and steel industry of the various steel producing countries of the world. It was a most harmonious convention and promised great results. They have not been fulfilled, for reasons not necessary to discuss at this time. But I claim that if the steel men who in 1911 were at Brussels and London respectively, for the consideration of the steel busi-

ness, were in control of international affairs, there would be no wars.

THE GREAT WAR

The war conditions in Europe are not only deplorable, but today they are desperate. We hardly know what to think, and we are not inclined to dwell upon a consideration of the possibilities. We have for some time realized and we see now more clearly than ever before that the precipitation of the war was deliberate and was influenced by a desire on the part of a few individuals in Germany to rule the world by force, regardless of right or reason.

We know that the German nation, controlled by the Prussians, is still dominated by the same spirit which resulted in the building up of the German Empire and which secured the control of other kingdoms against their will. It is intended to accomplish throughout the world what was then effected in the territory represented by the kingdoms which formed the German Empire.

For a long time I, with many others, did not believe that this disposition actuated Germany at the beginning of the war, but we have been forced to that conclusion. The evidence which has been produced from one source or another is convincing. If that be true, as I will suppose, we can understand why the military situation in Europe today is such as we read of in the newspapers.

Month after month and year after year there was a deliberate plan, and a persistent effort to carry it to success, to build up an organization which was calculated to make the military forces of Germany invincible; an organization which determined to subdue by force all the other nations one by one, and to finally secure the position of ruling the entire world.

We may carry our minds centuries back to the conditions of Europe and Asia and consider for a moment the desperate, despotic, arbitrary and cruel methods of con-

quest and lust, and we can see nothing worse than the things which are being done today.

It follows as a matter of course that with so much effort to prepare, to build up, to invent, to train, it is no wonder that Germany at the present time is successful and, as we may fear, will continue to succeed for some time to come.

It would be impossible for anyone, much less myself, to attempt to picture the misery, the agony, the suffering of mind and body, that is going on in France and other countries today. The conquering hosts are cruel to the limit in their methods and in their treatment; and even though we hope to be happily disappointed we must not expect, gentlemen, that in the near future there will be any great successes on the part of the valiant hosts who are fighting in defense of humanity.

In all history there has never been any picture of battle scenes and battle results which were so terrible as those now existing and which we fear may be long continued.

It would be useless to discuss what ought to have been done to prevent these conditions. We are not at this time particularly concerned with the past. Many of us, probably most of us, perhaps all of us who are present on this occasion, would have done things some years ago that were left undone. Some of us at our regular steel meeting in October, 1914, as forcibly as we could, presented our views as to what should be done to prepare for possibilities. But that is behind us. There were reasons for non-action. Whether they were valid or otherwise we need not argue at the present time.

It would not be useful now to refer, in the tone which I have adopted, to the awful things that are being done in Europe, except for the purpose of emphasizing, in the strongest words and in the best possible manner, the fact that we personally are not without courage, we are not without vision, we are not without appreciation of our responsibilities and duty. The people of this country.

represented by such as you, will never give up this fight (applause) unless and until (what we believe is not possible) Germany comes to this country and actually conquers and subdues the people who are here.

I was pleased to hear Mr. Schwab say night before last, and he will say it again this evening if he is present, which we now expect, that of all the different lines of industry the steel and iron people are doing better, more loyally and more effectively their duty than many others. And, gentlemen, we may have to do much more than we have done; we may have to devote more time and expend more money in assisting to carry on this war. Taxes are liable to be much higher than they have been. There is talk of doubling the income and the excess profits tax and of taxing many other lines of industry or activity. And we may expect very much greater hardships.

The individual who possesses little or nothing to be assessed, who represents little or nothing which can be taxed, is often quite prompt in saying it is immaterial to him how large the assessments are and that he is surprised people generally seem to be so indifferent and so selfish; but the men who are here this morning have and represent a great deal, and in dollars and cents they know that this war will be more costly to us as it proceeds. We know that our property—for most of us have some property—and the large interests which we represent, will be more and more heavily burdened. But in defense of the rights, the liberties of the men of this country, in defense of civilization itself, we do not care what the expense is or will be, provided it is equitably distributed, and provided, to the best of the ability of honest and faithful men, the money is well expended. (Applause.) We must and we will do every thing in our power to aid the Government.

THE INSTITUTE'S WAR WORK

The steel industry is doing much to assist in this war. The American Iron and Steel Institute has been carrying

on a very large work. It is in close communication with the Governmental officials day by day. It is a means for securing and distributing information to the Government officials. It is the agency upon which the Government depends very largely for assistance in carrying on many of the activities essential to the war.

Some of you know and some of you do not know that the staff of the Institute has been very largely increased, that the office room has been extended, and that Mr. McCleary and his faithful associates and assistants are devoting long hours in securing and furnishing to the Government such aid it needs and calls for. The Institute under this management is a credit to all of us, and it is of real value to the Government—to the general public. It has approached the position which eight years ago we all hoped it might in the course of time reach. We may well be proud of the fact that we decided to form this Institute, and that we have so faithfully stood by it.

The general committee, appointed by the directors of the Institute, have been doing valiant service. They have been devoting a great deal of time; they are giving all the affairs submitted to their charge, by direction of the Secretary of War, the Secretary of the Navy and the War Industries Board, their best thought and their energies in an endeavor to serve the Government faithfully and at the same time to protect the interests of the whole steel fraternity of this country. In referring to these matters I intend to exclude myself. It is a matter of gratification and it should be of peculiar pride to all the members of the Institute that they have such a general committee, well disposed, well trained, and well fitted to carry on this very great work.

And the sub-committees have all been rendering splendid service. You are familiar with the different committees. Some of you are not acquainted with their work in detail, and you would be surprised to know, perhaps, that many of these gentlemen, also work from early in the morning until late in the evening; and they are

laboring with very great satisfaction to all who know what they are doing and who are depending upon them. It has been a source of pride to me when I have noted the results. Too much praise cannot be given to them for their willingness, patriotism, and at the same time their loyalty to the industry. I am quite sure that all the manufacturers ought to be very well satisfied with what is being done for them by a comparatively few individuals.

We sometimes receive complaints, although good-natured, from different branches of the business, in regard to the effect of decisions upon their particular affairs. These are never ignored, but are carefully considered. The effort is made to correct mistakes and, if possible, to secure better conditions for the one who complains; but always with the intention of doing exact justice between all the different lines of this industry and between the steel producers and the Government.

To my knowledge there has never been any decision or action on the part of the men connected with these committees which has been actuated by selfish motives or considerations. So far as I have noticed, and I have endeavored to give careful attention, there has never been a determination on the part of any members of these committees which anyone could properly object to on the ground that it was unjust, illy considered or based on anything but the desire to be fair to all concerned.

And now may I say a word for the whole industry represented here today? I have on many occasions expressed my opinion of you and your associates. I have spoken in your favor; but I have never said half enough.

Steel men have marched up to the point of obligation at every opportunity with the most patriotic, the most loyal, the fairest disposition, having in mind the one idea of trying to serve the country faithfully in total disregard of personal gain or success.

Wherever duty and obligation to the country and personal interest or personal pride have come together in

opposition, so far as I know without exception personal interest and personal pride have been subordinated. Could anyone say more of any other man or any business than that? It is easy to talk. We all make claims of loyalty and patriotism. We are inclined to assert that it is our disposition to be just, but I am not talking about what the steel men have said; I am, rather, stating what I know by personal contact they have done. Whatever may happen in the future to us, to our business or to our country, we shall have the satisfaction of knowing that we did our best, with pure motives and with a desire to render service that our friends and our children may always know was creditable.

THE GOVERNMENT'S APPRECIATION OF STEEL MEN'S WORK

Now, this disposition and action on the part of the steel people has had some effect in Washington. There have been times when our whole business was criticised unfavorably by some. Even since our country entered the war your general committee has met officials in Washington who at first seemed disinclined to grant what, under all the circumstances, we believed we were entitled to.

You have read in the newspapers that it was the thought of governmental officials to take possession of the iron and steel industry and manage it, and you have read that it was proposed to do or not to do a good many things, which proposals seemed to you improper. I cannot speak for the future. I do not know what may happen. I do know that frequently there are government officials as well as others, even in our business, who prove to be incompetent to fill the positions which they occupy; and there is always danger of mistakes being made, and we may have reason for apprehension. We can speak of the present and the past—for that we know—and I believe my associates on the committee will confirm what I say: that heretofore, after we have met the officials in Washington and have had full opportunity to discuss with

them the questions raised or the action proposed, the final result has been, if not entirely satisfactory to us, yet in the main fair, all things considered.

There have been times when we have been more or less discouraged. Claims have been put forth that were not justified by the facts and the figures, and it has seemed to us temporarily there was great danger of our lines of business being injured and perhaps jeopardized, but by patience and perseverance and discussion we have been able to at least avert disaster, and have generally secured what was appropriate, certainly from the standpoint of the Government officials. (Applause.)

I am not seeking praise for our committee, nor attempting to do more than to satisfy you that your representatives have been faithful and diligent and have shown skill and wisdom and that you have made no mistake up to date in submitting the management of your affairs so generously to them. These results have been brought about by the splendid, generous trust which you gentlemen have reposed in this committee, and the fine spirit of patriotism and loyalty which you have displayed.

Today you will hear very little if anything in Washington against the iron and steel industry. You have demonstrated that the professions which you have been making during the last ten or twelve years were sincere. You said in your speeches at your meetings time after time that you had no improper intention relating to your management, that you were not disposed to do anything which would be injurious to the public interests, that it was a cardinal doctrine of the iron and steel men that they were striving to be of real benefit to the public, and that their conduct would finally be proven to be above reproach; and I believe all Washington is of that opinion at the present time. (Applause.)

The public press generally, long ago, gave you credit for right motives. As a rule it has been splendid in its appreciation of the service and the intention of the steel people during these years, notwithstanding there was a

different opinion in the minds of some of those in high public positions. I believe all feeling of hostility has been eliminated.

We find today Government officials in high places coming to the steel men with the statement that they want to co-operate with us, that they want our assistance; that they depend upon our loyalty and our ability to assist the Government in this time of great distress; and we have cheerfully and promptly responded.

It is to my mind a source of gratification that we may look forward to the future with hope and expectation that the Government of the United States will assist and will foster prosperity and business enterprise, instead of attacking it. (Applause.)

We must remember always that we cannot expect to get more than our just deserts. We must be loyal to the Government and to the law of the land. We must be reasonable and just, and expect that when we deserve censure we will receive it from the Government.

Carrying our minds back to the dark business days of 1907 and some that followed, and to the words spoken by many of the gentlemen now here concerning their intentions, we know all meant what they said—you have proven this. We know that in the future your acts will correspond with your heretofore expressed intentions and therefore that we may not only hope but we may expect there will be co-operation between the Government and the business men, and that consequently this country, if we succeed in this war, will have reason to occupy the highest and best commercial position of all the nations of the earth. (Applause.)

We are doing another thing, gentlemen; and the Government is permitting us, assisting us, urging us to do it. We are day by day putting our affairs in better shape; we may not be making so much money, or, if we do make it, we may be paying it out in excess taxes and in extensions to our works for the benefit of the Government at such abnormal cost that we are absorbing our

profits, but, nevertheless, we are putting our plants in better condition; we are becoming better prepared for the future, so that the iron and steel industry will be on a better footing than ever before, well prepared to succeed in the contest and the competition for international trade. If we win the war that will be worth something to us even if we do not save much in cash. If we lose the war then it is not so important whether we have anything or not. (Applause.)

On the whole, gentlemen, our business is good. We at least have a steady customer, and one able to pay. (Laughter and applause.)

Our prospects at the present time, notwithstanding the horrors and the cost of the war, are good. We have reason to be hopeful. The one who recognizes the dangers and the difficulties which are in sight is not necessarily a pessimist. I prefer the man who takes a broad vision, which covers disasters and possibilities of destruction, but puts his back against the wall, and, with his teeth shut, proposes to fight it out until success is achieved. (Applause.)

I do not care for the man who is so optimistic that he never sees anything but sunshine and prosperity and happiness, for he accomplishes nothing worth while.

Gentlemen, this is a time for good judgment, for patience, for level heads, for patriotism, and, above everything else, the grit that stands and fights and never gives up. (Applause.)

WHAT OF THE FUTURE?

For the long future I am an optimist. I believe we will win this war. (Applause.)

Why will we win it? Because, first of everything, we are right. (Applause). We ask for nothing that is of pecuniary benefit to us and which belongs to anyone else. We seek no territory. We are not even vindictive. We have no disposition to punish the evil doer from mere vindictiveness. But we know our rights and we seek

them, and we have the brains and the material strength and the courage to stand for them until they are secured. (Applause.)

Gentlemen, after the war is over, when history is written up, the fair-minded man who writes the account will say that in the ranks of the hosts of really fighting men, with fighting disposition, were the members of the iron and steel industry of America (applause); that they were behind, but in strong support of, the battle lines.

It is sad to contemplate the carnage in Europe. Words fail me when I allow my mind for a moment to dwell on personal situations. There is nothing that can compensate us for the suffering of our own people, of our boys who must go to the front and who offer themselves as a supreme sacrifice, if necessary; but there is comfort in the fact that no man or woman who sends the son to the war, or who loses the son in battle, ever expresses a word of regret that the boy went. There is no boy, so far as I know, who marches to the front, except with a statement that he is eager to get there, that he is willing to fight, that he knows his country is doing the thing it ought to do, and that he is perfectly willing to offer his life.

I remember in 1914, on the 3rd and 4th and 5th days of August, I took pains to go around the streets of Paris to see the mobilization of troops. I saw French soldiers by the thousands marching along the streets going to the stations to take trains for the battle line; and along with these boys and men were their wives and their sisters and their children, and their fathers, allowed by the gendarme to proceed without interruption; and, while everyone knew that every soldier so soon as he got to the front would probably be in the midst of battle, and that many, many of them would lose their lives, there was not a tear or a sigh to be seen or heard. Every woman, every child, every old man was encouraging the boys as they marched along the streets. (Applause.)

And such is the spirit of the people of this country.

Why is it so? Because we know, as the French knew, that we and they have the right on our side, and that the other side has nothing but might. Our cause is just and we must conquer. (Loud and continued applause.)

PRESIDENT GARY: The first paper on the program will be read by Mr. Ellicott of the Bethlehem Steel Company, one of the two authors.

THE CONSERVATION OF MANGANESE

C. R. ELLICOTT,

Superintendent of Furnaces and Mills

L. B. LINDEMUTH,

Superintendent of Electric Furnace and Crucible Departments,

Bethlehem Steel Company, Bethlehem, Pennsylvania

The effect of the war on the manganese supply for the steel production of America has taught us that our greatest industry is dependent in a large part upon the importation of manganese ores or manganese alloys.

In the past two years, material efforts have been made to increase the output of manganese ores and alloys within our own country, spurred on, perhaps, by the high price per unit of manganese in the ores. The effect of this effort has been felt, but the seriousness of the situation still remains. In the present and immediate future it is not only desirable and profitable to prospect for and develop manganese and manganiferous iron ores, but it is our patriotic duty to the economical situation of the country to do all in our power to increase the domestic production of manganese alloys and to conserve our available supply. There is no doubt that sufficient manganese ores and manganiferous material exist within our boundaries to meet our own requirements until normal conditions return; meanwhile, it will be necessary for a broadminded spirit of national welfare to exist, first among the steel manufacturers, and second, between the manufacturers and the steel consumers.

It is not the object of this paper to say what shall or shall not be done. It is only, first, to show, with the information available, the true manganese situation; second, to suggest, from a manufacturer's point of view, possibilities of conservation, and to request suggestions and criticisms which will produce a national saving of this

important metal. If the situation is squarely faced—habit, hearsay and tradition thrown aside—a general modification of standard practice and an intelligent revision of specifications, both as to raw materials and finished products, will effect considerable saving of manganese.

THE EFFECT OF MANGANESE.

The influence of manganese must be appreciated to its fullest extent in steel manufacturing; and equally important, its effects upon the finished product must not be overrated if any economical departure from our present standards is to be made.

Manganese is used in steel making for three distinct purposes:

1. In the melting operation, it is of great advantage, up to a certain percentage of the charge, as a deoxidizing agent for making ingots which can readily be rolled or forged with the minimum amount of scrap and defective material.

2. It is used in specified percentages to give desired physical results in the finished product, acting as an alloy.

3. It is added to obtain a specified percentage in the finished material, but not for the hot working qualities of the steel nor for desired physical properties which would necessarily be a function of manganese. It is added as a matter of accepted practice, subscribed to by both producer and consumer without considering manganese conservation.

These three purposes are considered in detail as follows:

1. AS A DEOXIDIZING AGENT: In the average open hearth practice .60 to .80 manganese is in the charge from the pig iron and scrap. All furnace reactions—including decarbonizing, dephosphorizing and desiliconizing—are oxidation processes. Some oxides are soluble in molten steel. When the steel is near the point of solidification, these will usually generate gas, thereby forming blow

holes, which later appear as surface or internal defects in the finished product. In addition, oxides contribute to what is commonly known as "red shortness" or brittleness when hot. Manganese material in any form in the initial charge prevents the formation of soluble oxides in the steel, or reduces what might be formed during the period when the steel is molten. In other words, if an appreciable percentage of residual manganese can be maintained in the open hearth furnace from the time the charge is melted until it is tapped, further additions of manganese can be eliminated in high carbon steels, and greatly reduced in lower carbon steels, to produce the same ductility in rolling which would be expected from heats which were low in residual manganese and finished with high manganese recarburizing additions.

This practice will not reduce the total pounds of manganese added to a given ton of steel, but it will permit the use of the lower grade of manganiferous material available in this country to replace the higher grade material which in normal times has been imported.

2. PHYSICAL PROPERTIES: The second use of manganese is to give special physical properties to the finished product, subdivided as follows:

- (a) Steels used in the rolled, forged, cast or annealed condition.
- (b) Steels heat treated.
- (c) Special manganese steel containing 11.00% to 14.00% manganese.

Subdivision (a) contains by far the greatest tonnage of steel produced. The effect of manganese on the physical properties of these steels is to increase the elastic limit and tensile strength. In cases where this is the sole purpose of manganese additions, we suggest the use of other strengthening elements, preferably carbon.

Subdivision (b) consists of heat-treated steels of normal manganese content. The effect of manganese is similar to nickel, except that its influence is not so marked.

Its effect is to retard the transformation of austenite in cooling. The use of manganese for improving the physical properties of heat-treated steels is not essential, as this improvement can be obtained by other available elements. We would, therefore, suggest that where nickel can be substituted the use of manganese be restricted; and in other cases, where it plays no part in heat treated results, that it be reduced to a point where its function is of forging or rolling importance alone.

Subdivision (c) : Hadfields manganese steel containing 11% to 14% manganese is a special product with special physical properties due to the manganese content. No change in present practice for this steel can be made.

3. SPECIFICATIONS: The other function of manganese is to fill specifications. There is no question but that many consumers specify a manganese content for no reason within their knowledge and for no special purpose. A large tonnage of the steel produced is made to both physical and chemical specifications. If only the physical qualities in forged, rolled, cast or heat treated products were specified, the manufacturer would be free to economize in manganese.

MANGANESE REQUIREMENTS FOR STEEL MANUFACTURE.

The statistical record of steel products for 1917 has been delayed; but as the total product of 1917 was very close to that of 1916, the 1916 figures will be used.

We have classed the various grades of steel roughly according to manganese content usually specified. These classes are arranged in the order of their tonnage importance.

Class 1. Low carbon steels below .25 carbon, such as structural steel shapes and plates for bridges, buildings, etc., boiler and fire box steel, plates, shapes and bars for railway cars; low carbon splice bars, forging steels, rivets, pipes, tubes, tin plate, bolts, sheets, spikes, tie plates, wire rods, merchant bars, etc.

Class 2. Medium carbon steels .25 to .80 and high

manganese steels, including Bessemer and open hearth carbon steel rails, quenched high carbon splice bars, nickel, structural, rivet, silico-manganese spring steel, chrome-vanadium automobile and railway spring steels, machinery, ship and structural forgings, alloy, machinery and commercial forgings, heat treated axles and shafts, steel wheels and tires, carbon shell steel, rifle barrels, small arm parts and low carbon open hearth and Bessemer cold drawn screw stock.

Class 3. High tensile carbon and alloy steels containing 0.60% to 0.70% manganese. In this class is included gun forgings and castings, marine and heavy machinery forgings and castings, structural ship steels, automobile bar stock, forgings, etc.

Class 4. High carbon low manganese steels, high carbon and other steels involving comparatively small tonnage. This would include file steel, armor plate, armor piercing sheels, carbon and alloy tool steels, carbon spring steel, nickel chrome commercial bar stock, punches, dies, etc.

The tonnage of ingots of these classes was approximately as follows, for the year 1916:

<i>Class</i>	<i>Tons</i>	<i>Per Cent of Production</i>
1	21,350,000	49.89
2	11,998,187	28.06
3	9,008,186	21.07
4	417,307	0.98

Class 1. The steels of class 1 are considered as low tensile or soft steel, having as a rule an ultimate strength below 70,000 pounds per square inch. The method of manufacture for the same grades varies among manufacturers. Some prefer to make what is known as "dead" steel, which contains on an average 0.60% manganese; others "churned" or "rimmed" steel, analyzing on an average 0.35% manganese. We will assume that the average of all steels in Class 1 is 0.50% manganese. The residual manganese in the steel bath in the furnace would be less than 0.10%, so that with 30% loss of manganese

added, this steel would require an addition of 0.60% of metallic manganese, or a total of 128,100 tons.

Class 2. In Class 2 the manganese varies from 0.40% to 1.40% manganese, the average being about 0.70%. The method of adding manganese to these steels varies considerably, depending upon plant construction and the individual opinion of the operators. At present there are five methods in common use for adding manganese:

- (a) Adding cold crushed ferro-manganese in the ladle or furnace.
- (b) Melting ferro-manganese in electric or oil furnace, or in special cupolas, and adding molten in the ladle.
- (c) Melting spiegel in a cupola and adding direct or diluted into the ladle.
- (d) Adding about 5% manganiferous pig iron from mixer or cupola to furnace or ladle.
- (e) Recarburizing with 1.00% to 2.00% manganese iron in the furnace or ladle and adding the balance of the manganese in alloy form.

In this class of steels probably the greatest proportional conservation of manganese could be accomplished. Assuming a residual manganese of 0.10% before tapping, and a normal manganese loss of 20%, this class would require an addition of 0.75% manganese, or a total of 89,986 tons of manganese.

Class 3. In class 3 a considerable percentage of the product today is forgings for guns and ships and castings made from both acid and basic steels. These steels we will consider as high grade products, low in sulphur and phosphorus. It is a common practice to add in the neighborhood of 0.20% to 0.30% manganese to the charge in the form of ferro-manganese or low phosphorus spiegel in order to increase the manganese content of the charge to about 1.00%. These steels will average 0.65% manganese in the finished product, and will have a normal manganese loss of 20%. With a residual manganese of 0.15% before

tapping the final additions would be 0.63%. With 0.20% manganese charged, the total requirements would be

In Charge.....	18,016 tons manganese
Final Additions.....	56,751 tons manganese
Total	74,767 tons manganese

Class 4. In class 4 the manganese additions are small, for, to use a mill term, the heats are "caught coming down," as recarburization is started when the desired percent of carbon is reached, and the manganese, as a rule, is within specifications. We will say that this grade requires an addition of 0.10% on an average, or 417 tons of manganese.

The total manganese requirements from 1916 figures are therefore:

Class 1.....	128,100 tons manganese
Class 2.....	89,986 tons manganese
Class 3.....	74,767 tons manganese
Class 4.....	417 tons manganese

equivalent of 366,600 tons of 80% ferro-manganese.

MANGANESE SUPPLY FOR STEEL MANUFACTURE.

The manganese alloy production and imports of the United States for 1917 was:

Ferro-Manganese produced.....	286,000 tons
Ferro-Manganese imported.....	45,381 tons
Spiegel produced.....	193,291 tons
Total contained manganese produced and imported.....	304,000 tons
Manganese ore imported.....	629,971 tons
Ferro-Manganese from imported ores.....	300,000 tons
Contained manganese in alloy produced from imported ores..	240,000 tons

The domestic production of high grade manganese ore for 1917, is estimated by the U. S. Geological Survey at 122,275 tons, and this is expected to reach 172,900 tons in 1918. Using the 1918 figure, this will net us but 70,000 tons of 80% ferro-manganese or 56,000 tons of contained manganese. The low grade ores are being produced at an estimated rate of 800,000 tons for 1918. This will yield about 340,000 tons of an alloy containing an average of 35% manganese or 119,000 tons of contained manganese.

The situation is, therefore, briefly this: We require, at our present rate of steel production, present specifica-

tions and methods, 293,270 tons of contained manganese per year, and we are producing in 1918 at the rate of 175,000 tons from our own raw materials.

There is no question that the importation of manganese ores or ferro-alloys is undesirable at the present time. We have the manganese in our country—enough manganese to be independent for some years. We can produce it and can certainly devise means to make it applicable to our steel production in the immediate future. We have been accustomed to the use of 80% ferro-manganese in the manufacture of open hearth and soft Bessemer steels, but we can substitute lower percent manganese alloys for this work. This can be produced in our own country, particularly if the specifications for steel have their manganese limits reduced.

The majority of the steels in Class 1 could be “churned” or “rimmed” steel with 0.20% to 0.40% manganese, and of as good quality and, at the same time, eliminate the use of high grade ferro-manganese.

In Class 2, recarburizing could be done with 5% to 6% manganiferous iron, or spiegel and iron below .15 phosphorus, mixed in the proper proportions and added molten.

In Class 3, the highest grade ferro-manganese should be used for probably half of the product. With comparatively low carbon and high manganese, the low grade manganese alloys would not be suitable because of the proportion of manganese to carbon. In acid steels of low phosphorus, the use of the lower grade alloys would be prohibitive, due to the impossibility of producing a low-phosphorus low-manganese alloy.

In Class 4, spiegel or alloys containing less than 20% manganese could be used entirely.

By using pig iron containing 2.00% to 2.50% manganese in open hearth charges, the residual manganese in the steel before tapping will vary between 0.20% to .40%, so that in many cases further additions of manganese for deoxidizing purposes are not required, and the final man-

ganese additions are for physical properties only. With basic steel at .40% carbon, 10 points of manganese would add 2500 pounds per square inch to the tensile strength. The same effect could be accomplished with three to four points of carbon. As an example, all the Standard specifications for open hearth rails today call for manganese limits from .60% to .90%. There is no reason why this specification should not be changed, reading manganese .40% to .70%, with a higher carbon adjustment to give the same physical qualities. It would appear, therefore, that at least an average of 15 points of manganese could be reduced in the specifications for steels in Class 2.

Without the use of high manganese pig iron in the charge, assuming our previous conclusions are possible, the requirements of ferro-manganese and spiegel and lower manganese alloys would be as follows:

	<i>Metal Mn.</i>	80%	60%	40%	20%	6%
<i>Class</i>	<i>Required</i>	<i>Fe.Mn.</i>	<i>Fe.Mn.</i>	<i>Fe.Mn.</i>	<i>Fe.Mn.</i>	<i>Fe.Mn.</i>
1	100,345	0	25,085	40,138	346,200	0
2	71,990	0	0	0	179,975	598,715
Charge 3	18,016	35,470	0	0	141,880	300,300
Final	56,751					
4	417	0	0	0	2,085	0
Total,	247,519	35,470	25,085	40,138	670,140	899,015

By changing or standardizing our method of recarburizing, adopting a standard process for the manufacture of soft steels and lowering our specified manganese requirements where possible, we can reduce the total tonnage of manganese from 293,270 tons to 247,519 tons or 15.6%. Further, the requirements of 80% low phosphorus ferro-manganese is reduced to 35,470 tons.

The estimated production of 80%—ferro-manganese from domestic ores will net us 70,000 tons for 1918, which is sufficient for the country's needs. The manufacture of 60% ferro-manganese will require high grade ores so that 25,085 tons of 60% ferro-manganese will lower the possible production of 80% from 70,000 tons to about 51,200 tons. Of 40% ferro-manganese, 40,135 tons should be made from the lower grade ores. This will require ap-

proximately 100,000 tons of ore. This leaves about 700,000 tons which will produce 520,000 tons of alloy averaging 20% manganese. This would leave a shortage of 150,140 tons of spiegel.

In the last twelve years the spiegel production has varied from 83,000 to 348,000 tons per year. What proportion of the ore available for the manufacture of 35% manganese has heretofore been used for spiegel manufacture is impossible to estimate without a detailed canvass of the various producers. The fact remains, however, that there are great quantities of low grade mangiferous iron ores in this country. The use of 1.50 to 2.50 manganese pig iron in the open hearth charge would reduce the quantity of manganese required for additions, approximately 15% for basic open hearth steels, or a further reduction of 10.6% manganese in the total steel produced.

There is ample reserve of ores to produce sufficient 5.00% to 6.00% manganese recarburizing iron for a considerable period. The annual requirements of this grade would be approximately 900,000 tons, which could probably be increased to produce a further saving of 20% spiegel.

PHOSPHORUS CONTENT OF MANGANESE ALLOYS.

It has been customary for us to specify a phosphorus content in ferro-manganese of not over .250%. This is probably not so vital as we have always considered it. For example, an addition of 0.60% manganese, using 80% ferro-manganese of 0.25% phosphorus, would cause a phosphorus addition to the steel of less than .002%. In most cases this limit of .25% could be appreciably increased without affecting the quality of the product. The addition of 0.50% manganese through the use of spiegel would add to the steel 12 points of carbon, and assuming we could afford to add 0.15% of phosphorus, the spiegel could contain 0.600% phosphorus. This is well above the content which spiegel produced from our own ores would

contain. For basic steels this would be no hardship; for sheets and tin plate it would be an advantage; but for high grade acid steel, the 80% ferro-manganese would necessarily be used on account of the phosphorous.

The phosphorus content of our domestic ores is roughly estimated as follows. The estimated production for 1918 is from the U. S. Geological Survey.

High Grade Manganese Ores—40% and above.

<i>State</i>	<i>1918 Productions</i>	<i>Probable Phosphorus content</i>
Alabama	200	0.200
Arizona	22,000	0.050
Arkansas	10,000	0.200
California	12,000	0.100
Colorado	500	0.200
Georgia	5,000	0.100
Montana	81,600	0.050
Nevada	2,500	0.100
New Mexico	1,500	0.100
N. Carolina	100	0.150
S. Carolina	2,000	0.150
Tennessee	5,000	0.150
Texas	2,000	0.050
Utah	4,000	0.150
Virginia	20,000	0.200
Washington	1,000	0.100
Wyoming	500	0.100
Total	169,900	

Low grade ores for manufacture of 35% ferro-manganese:

Appalachian Region	40,000	0.200
Arizona	25,000	0.100
Colorado	100,000	0.200
Lake Superior	150,000	0.200
Lake Superior	150,000	0.090
Montana	25,000	0.080
New Mexico	36,000	0.100
Zinc Residuum	175,000	0.040
Miscellaneous	15,000	0.200
Total	716,000	

A serious difficulty which becomes apparent from the above tabulation is the selection of furnaces for the manufacture of the various alloys, the economic transportation of raw materials and the distribution of the product to the best advantage. How this can be done will require thought and cooperation on the part of all consumers of manganese.

CONCLUSION.

As a metallurgical proposition we have tried to show how the manganese situation of today can be met in the various steel making departments in our own plants; and, if we assume that we are representative of the industry by applying the same methods to the country as a whole, we feel that the situation can be met.

The steps as outlined are briefly:

1. United effort and cooperation of all steel producers on a pre-determined set of plans.
2. Cooperation of the steel consumer in revising downward the specified percentage of manganese in finished steel and upward allowable limits of phosphorus.
3. The use of manganiferous iron in open hearth charges to increase the residual manganese in the open hearth process.
4. The production of a majority of soft steels by the "churning" or "rimming" methods.
5. The use of approximately 6% manganese iron with phosphorus below .150% for recarburizing.
6. The use of 20% spiegeleisen, 60% and 40% ferro-manganese for recarburizing.
7. The use of 80% ferro-manganese only in high grade low phosphorus acid steels, high speed and carbon tool steels made by the crucible process and manganese steel of 11.00% to 14.00%.
8. Each individual plant will have its own problems; some will not be properly equipped, some will be making specialties of which we have no record. The problems will be many and difficult, but they can be worked out, if the united determination of the manufacturers is, that it will be worked out.

With our present methods of recarburizing, if imports were suddenly cut off we would find our production of

steel greatly impaired. Our country is actually short less than 160,000 tons of 20% spiegel or 11% of our manganese requirements, if we will use to best advantage the ores that we are producing at our present rate. But with our present methods we are short approximately 40%. The ores are available for spiegel production, but they must be mined and converted.

It cannot continue to be a question of costs, nor can the usual routine of specifying and buying ferro-manganese remain. This situation demands the guidance of a strong, able, impartial committee of the American Iron & Steel Institute which knows, and can tell or show how our materials are to be used.

With such a body of men and the hearty cooperation of every steel plant in the country, we can make our greatest manufacturing industry as independent as it is great.

PRESIDENT GARY: That has been a very instructive paper. It will now be discussed by Mr. Diehl of the Carnegie Steel Company.

THE CONSERVATION OF MANGANESE

Discussed by A. N. DIEHL

Assistant to Vice-President, Carnegie Steel Company, Pittsburgh, Pa.

The paper presented by Mr. Ellicott and the discussion, so far presented, very clearly indicate the general methods in use for the conservation of manganese, and it might be well to draw further attention to the general underlying principles involved, as well as to some salient practice features which should not be overlooked.

The whole problem of manganese conservation divides itself automatically in two parts:—

- (1) Prepare the ferro alloys to the best advantage of the available ore supply, and ultimate use of such alloy.
- (2) Consume the alloys to the best economic advantage, with regard to the proportionate supply, and adequate practice supervision.

RESOURCES AND ALLOYS.

Manganese ore in the United States is scattered, and occurs generally in pockets, causing considerable irregularity of product. Quite a large proportion of the tonnage contains rather high phosphorous. It may generally be stated that any low phosphorous ore containing over 6 to 1 ratio between iron and manganese with a content of 40% iron or over, might be considered as a source of recarburizing manganese. Mixtures of such lower grade ores with higher ones can be varied to produce any predetermined alloy, depending on the metallic ratios. It might be well to study this phase after a canvass of the deposits is available, and determine if any *grade between* the commonly called ferro manganese and spiegel grade would be desirable.

As manganese alloys with iron in practically all pro-

portions, the terms manganiferous pig iron, spiegel, and ferro manganese are merely arbitrary trade demarcations; but on account of their specific uses, they have been looked on in many cases as alloys having different inherent qualities.

The production of ferro manganese of the 80% variety, requires ore of high manganese content, most of which is imported. The shipping and embargo conditions make it absolutely necessary, therefore, to use such cargoes to the best advantage, namely, by mixing with our native production in such manner as to make the greatest quantity of manganese in the latter available as an alloy. This will result in the consumption of lower alloys than we were formerly accustomed to. The application of the spiegel cupola practice, principally for low grade alloys, is extremely flexible, and a manufacturer of high-carbon steel, especially in quantity, should consider such installation carefully. In most cupola practice, the alloy is diluted with pig iron to 5 or 6 per cent of manganese, depending on carbon and manganese specifications, and a pig iron of such composition made from one not at present considered in the manganese reserves, would be especially desirable. A 16% alloy cannot be used in open hearth practice for carbon below .25 to .30, and a portion of it, at least, will have to be melted or charged in the furnace.

METHODS OF ADDITION.

Manganese is introduced in the steel in several different ways:—

- (1) In the ladle cold, or heated, as is generally done in the Bessemer process with a loss of 20% to 25%.
- (2) In the open hearth furnace, where it is melted with the bath and having an accompanying loss of 50%.
- (3) As a combination of the two former methods

where conditions are heavy with an average loss of approximately 50%.

- (4) In the molten condition, introduced into the ladle with a loss of 15% to 20% in spiegel and 20% loss in ferro, or as in manganiferous pig iron recarburization, where it is poured through the furnace showing a loss of 25% to 30%; but such manganese should be considered as constituent of the iron rather than in the recarburizer class.

The chemical range of the carbon content in the iron-manganese alloy of 95 to 2, and 12 to 80 proportion, is approximately from 3.75 to 6.50, increasing gradually through the different ranges with slight variation, due to the other metalloids. As the carbon range is thus comparatively small, the manganese content is the principal factor determining which should be the proper alloy to use.

As long as 80% ferro was available, the cold ladle addition was the most economic course to pursue, and should be utilized to the fullest extent with the more diluted grades. Cold ladle additions up to 30 pounds per ton, should not be excessive. We have used 40 pounds per ton in 60-ton heats at a number of plants. Care in heat manipulation, however, is necessary in such cases. Obviously, the carbon requirement will be the determining factor. The Carnegie Steel Company of the U. S. Steel Corporation, as well as several other subsidiaries, have for a considerable period been using 60% ferro as a substitute for the 80% grade, and obtained equally good results. The only change noticed was in raising the carbon limits somewhat, the low practical limit being about .12 carbon. With a 50% grade, making .50 manganese steel, the carbon low limit would be about .16. All higher carbon or manganese specifications can be met without difficulty. The U. S. Steel Corporation has changed its spiegel grade to 16% manganese, with a prospect of still further reduction.

PRACTICE CONSERVATION.

The greatest real conservation will, of necessity, be centered in the judgment and activity of the operator, who must appreciate the urgency and expediency of such effort. It might be well to add a few reminders in the form of *DON'TS*, which although well known are sometimes overlooked, and may serve either to close an avenue of loss or as an idea trending toward further investigation.

DON'T, *as an industry*, retard your quality or quantity to any appreciable extent.

DON'T forget that the foreign supply of manganese ore is largely embargoed, and water transportation almost prohibitive; and also that steel, up to the present date, cannot be made without manganese.

DON'T overlook the fact that there are some low manganese deposits in this country which can be worked, with some difficulty perhaps, but which must be utilized to bring up the available supply necessary to carry on full operations.

DON'T, *as a manufacturer* of manganese alloy, allow any wastage of metallic content beyond what is absolutely necessary, and keep the percentage of fines to a minimum. Large lumps will sink into the bath while the fines will often be lost in the slag. Keep alloy away from moisture. Be careful to keep grades separated and ores properly analyzed, and mixed for specific grades.

DON'T, *as a manganese alloy consumer*, allow melters and helpers to cover bad melting practice by large additions of manganese to restore over-oxydized conditions in the

furnace. Proper attention to the melting of heats will save both Manganese and money.

DON'T use high grade alloy when a lower will suffice, as in our native supply the low grade ore is greatly predominant. Melting the recarburizer and pouring direct into the ladle, thereby being able to use a low alloy, should be done wherever justifiable and practicable; also do not waste high-manganese scrap or slag having the proper chemical contents for recover. The scrap can be used in spiegel cupolas.

DON'T put any alloy into the furnace direct until the maximum of cold ladle additions are made. Pre-heat if deemed advisable. Authorities differ as to this, but we may assist in solving the controversy. Some few steel specifications will require a washing and others excessive amounts of manganese, which must be furnace additions, but the most conservative methods should be applied in accomplishing the purpose.

DON'T overlook the manganese in pig iron when it can be used to recarburize, as its manganese can be of great use, especially in high-carbon, low manganese specifications, also high-manganese iron will give 3 to 5 points more residual than a lower one, thus making available a supply otherwise wasted, as this manganese could not be considered under the recarburizer grade.

DON'T forget that high-carbon heats caught "coming down" will retain a high resi-

dual manganese if a fifty-fifty iron and scrap charge and no run-off slag is used; .20 to .25 may be saved in many cases. With a run-off slag the manganese is mostly lost.

DON'T, *as a steel consumer*, insist on a maximum manganese specification if one of lesser chemistry is equally applicable and capable of performing the same duty. The steel manufacturer must still meet the requirements and will not go beyond a point where the product may be affected. Also some of the native ores contain considerable phosphorus, and a high limit to .06 or .07 in open hearth and a few points in Bessemer steel will not affect a hardship in many cases, especially in material where a little risk is encountered.

The above pertinent remarks may outline a few of the ways in which saving may be affected. The plan is offered not as a manufacturer's request but as an *urgent call* for a General Manganese Conservation Rally. The subject is of sufficient importance to justify every manufacturer or consumer to be equally concerned, and aid by every means in his power the conservation of this necessary element, as well as to make available a portion of our native resources of manganese, for which we have heretofore been dependent on other nations.

PRESIDENT GARY: Further discussion by Mr. Waterhouse of the Lackawanna Steel Company.

THE CONSERVATION OF MANGANESE.

Discussed by GEORGE B. WATERHOUSE,

Metallurgical Engineer, Lackawanna Steel Company, Buffalo, N. Y.

Mr. Ellicott's paper on this very important subject has covered the ground in a concise, able manner, and he is to be congratulated on having pointed out so clearly the need for conservation and for having given various definite ways in which it can be brought about. The subject of the supply and conservation of manganese is a very large one and to us as steel makers and steel users a vital one, for manganese has to be carefully considered in the making of every pound of steel. It is a big subject, with many factors not readily apparent. Because of its importance it has for many months engaged the attention of various groups of men. We, as an Institute, may take pride in the fact that our Sub-Committee on Ferro-Alloys has done and is doing some of the most valuable work in the country today in this connection. At a recent meeting called by the Sub-Committee in Pittsburgh, which was well attended, the decision was reached that standard Ferro-Manganese should be lowered from 80% to 70% Manganese, and standard Spiegeleisen from 20% to 16% Manganese. This decision makes available very large tonnages of ore in this country. Also our Sub-Committee is working in the closest touch with the Shipping Board and the War Industries Board, the present arrangement with the former being that ship tonnage will be provided for the importation from Brazil of 35,000 tons per month of high grade manganese ore. Also the Bureau of Mines must be mentioned. This quiet but most efficient branch of the Government service has been indefatigable in following up and placing on record all possible sources of supply in this country. It is also working with the steel makers along the lines of the proper use and conservation

of the various grades of manganese alloys when produced.

These various agencies have mainly occupied themselves with the obtaining of the necessary supplies of manganese alloys. It remains for us, as steel makers and users, to devote our best efforts towards the proper and economical use of the alloys when made. Although exception may be taken to some of Mr. Ellicott's statements, the important points in this connection have been well covered by him. There are numerous definite ways in which our own domestic manganese resources can be utilized without restricting the output or lowering the quality of the steel made, for two of the most important factors of this big subject are that tonnage must not be reduced and quality must not be lowered.

As Mr. Ellicott points out, the ordinary low carbon steels constitute about 50% of the country's production. For the majority of these steels the low limit of the manganese specification should be removed entirely, which would allow the steel maker to furnish steel with approximately 10 points less manganese than at present. This in itself would bring about a great saving, and by the use of a 70% or even a 60% Ferro-Alloy the domestic manganese ores could be drawn on to a much larger extent than at present. Mr. Ellicott is also perfectly correct in laying stress, as he does, on the importance of the residual manganese in the open hearth bath. By making special arrangements and paying attention to local conditions the manganese in the basic open hearth charge can be raised in many cases. This will bring about important results that cannot be gone into now, but among them will be an increase in the residual manganese in the bath, and this in itself will greatly reduce the final additions of manganese alloy necessary. This is such an important matter, one that can lead to such great savings, and one so little understood even by open hearth men, that a little more may be said on it.

In the case of ordinary open hearth plate let us assume

that the specifications are so changed that the steel maker can safely aim at .35% manganese in the finished steel. If the residual manganese in his bath is .10%, then enough manganese alloy has to be added to take care of the oxidation loss and introduce .25% into the steel. Now by making suitable arrangements let us assume that the manganese in the original charge is raised so that the residual manganese in the bath is .20%. He then has to add to his metal enough alloy to take care of the oxidation loss (which in this case will be less) and to introduce only .15% into the steel. This means a direct saving in final ferro-manganese additions of 40% to 50%, and nothing has been assumed but what is feasible, and can be carried out in practice.

Another very important class of ordinary steels contains .35% and upwards of carbon, and at the present time constitutes certainly 25% of the country's output. It includes all the rail and shell steel, and many forging steels. It would be injudicious to change the manganese specification in many of these steels, but some saving could be brought about by paying attention to the residual manganese in the bath. The most constructive work, however, in regard to these steels, and the greatest measure of conservation would be to adopt methods that would utilize the low manganese alloys; that is, methods of adding manganese similar to Mr. Ellicott's (c) and (d) which may be quoted :

- (c) Melting spiegel in a cupola and adding direct or diluted into the steel ladle.
- (d) Adding about 5% manganiferous pig iron from mixer or cupola to furnace or ladle.

The Lackawanna Steel Company has for a number of years followed a method of this kind in making these grades of steel, and a few details may be of interest. For instance in making rail steel the open hearth bath is tapped with .15% Carbon, and an addition of molten spiegel mixture is made in the steel ladle that will add

the desired amounts of carbon, manganese and silicon. The usual practice on rail steel is to charge into the spiegel cupolas a mixture of spiegeleisen and pig iron that will average $6\frac{1}{2}\%$ manganese, and the usual amount of molten spiegel is 28,000 lbs. for a heat giving 100 tons of ingots. On shell steel the spiegel mixture charged into the cupola averages 9% manganese, and the amount of molten spiegel added to the steel ladle is 14,000 lbs. for a heat giving 100 tons of ingots. Such a method is entirely practicable, as may be judged from the fact that we use it in making about 50,000 tons of ingots each month. It does not interfere with output but on the contrary helps to increase the tonnage; and as regards quality it gives material that is remarkably uniform from one ingot to another, that rolls well, and that can be confidently subjected to the most rigid tests. There is no doubt that along the lines of methods similar to ours, and of methods (c) and (d) given above, the use of ferro-manganese can be largely done away with in making these grades of steel, and a conservation of manganese be brought about that will be of great importance, because the low manganese ores of this country can be used in making the alloys required. It may be mentioned that our President, Mr. E. A. S. Clarke, has publicly stated that we at Lackawanna stand ready at any time to explain and show our method of using spiegel and to do all we can to enable others to work out similar methods to meet their own conditions.

PRESIDENT GARY: Further discussion by Professor Richards.

THE CONSERVATION OF MANGANESE.

Discussed by J. W. RICHARDS

Professor of Metallurgy, Lehigh University, South Bethlehem, Pa.

Mr. Chairman, I have no doubt that by increasing our domestic output of manganese ores, by avoiding useless waste and by substituting other materials where possible, this country is within measurable distance of becoming independent of foreign supply.

The use of manganese to fill unnecessary specifications is certainly one which should receive immediate and effective attention. It is a clear waste.

A source of manganese for our blast furnaces which is not at present utilized is the slags from spiegel furnaces. These contain considerable manganese and would be self-fluxing in the blast furnace, and a considerable proportion of their manganese saved.

My friend, Mr. Poulsson, of the Stavanger Steel Works, in Norway, confirms the fact that spiegeleisen of quite low grade can effectively replace ferro-manganese in most steels, and that calcium carbide can be partly substituted for ferro-manganese in deoxydizing steel. In a recent letter to me he states that 10% to 12% spiegel, or even 8% to 10%, can replace ferro-manganese entirely in all grades of rail steel. To preserve the manganese and keep down the carbon the spiegel should be melted in an electric furnace, and not in cupolas. Necessary silicon can be added as ferro-silicon. For soft steel, such as steel plates, angles, etc., the 80 per cent ferro-manganese can be replaced by half its weight of 60 per cent ferro-manganese, if calcium carbide is substituted for the other half. For instance, in place of 8 to 12 pounds of 80 per cent ferro, 4 to 6 pounds of 60 per cent ferro is used in conjunction with 14 to 16 pounds of calcium carbide. The latter is used in pieces 0.3 to 0.4 inch in

diameter, is mixed with the ferro and thrown onto the bottom of the ladle. The steel is poured upon the mixture, especial care being taken that the steel strikes the carbide before the slag comes in. This is most easy to accomplish when using a tilting furnace. Additional de-oxidation, if required, can be done by powdered 50 per cent ferro-silicon and aluminum. The exact quantity of carbide to use for any steel can be easily found by a little experimenting.

Calcium carbide can thus be employed to diminish our manganese requirements. Whether it is commercial or not depends on the relative costs of 80 per cent ferro, 60 per cent ferro and calcium carbide.

By the use of such and similar practices, by saving our manganese wherever possible, and by increasing our domestic production as fast as possible, we can feel assured that within a short time this country will be independent of importations, and that the precious ships now used to bring in high grade manganese ores can be diverted to more direct service for our army and navy.

PRESIDENT GARY: Any further discussion? (A pause.) If not, we will now hear Mr. J. G. West of the Jones and Laughlin Steel Company on "The Design of the Modern Blast Furnace."

THE PRINCIPAL CHANGES IN BLAST FURNACE LINES DURING THE PAST TEN YEARS

JAMES G. WEST, JR.,

General Superintendent, Blast Furnaces, Jones & Laughlin Steel Company,
Pittsburgh, Pa.

Any one making a careful study of the results achieved in the modern blast furnace plant, would find it very difficult to assign attainments to any one particular line of designs, control, or operation.

Blast furnace design has not reached a point of mathematical precision, where amount of product can be figured within a small percentage of the theoretical desired, such as the mechanical and electrical engineers might do with the designs of large turbines, generators, etc. We often hear of a turbine design projected for thousands of horse power for a working machine, with results that are very close to contract figures.

Not so with most metallurgical furnaces; particularly the blast furnace which no one yet has been able to radically alter in its process methods. Most results that are gained may be shown by figures of comparatively small percentages, and these as a rule have been developed over a long period of years of experimentation. Very often these periods represent only cycles in the efficiency curves.

To reach the point of efficiency, production, and smoothness of operations, which is the aim of all, certain lines of procedure must be observed in the assembling of the different ends to get the desired results. One would classify these under the four general heads, as follows:

1st. Perfect knowledge of the material must be had beforehand, both physically and chemically, and these should have as much regularity as possible.

2nd. Proper designs of apparatus.

3rd. The organization must be keyed up to the highest point of skill, and fully educated in the program to be

pursued, and in the results desired. The modern blast furnace is no longer a one-man proposition in its regulation.

4th. The mechanical equipment must keep running with a smoothness that will not hold back any of the other developments. Very often this is found to be a weak point in the working out of new designs in the metallurgical end.

No one of these points can be neglected if the whole proposition is to be rounded out.

Up to the year of 1900, the majority of the furnaces of the steel-making companies had been served with a superior grade of coke from the old Connellsville basin, with a fixed carbon from 89% to 90%, ash as low as 10%, and sulphur around .8%.

DRY ANALYSIS OF FUEL OF A REPRESENTATIVE COMPANY

<i>Year</i>	<i>Ash</i>	<i>Fix. Carb.</i>	<i>Sul.</i>
1900	10.74	88.04	.93
1901	10.79	89.12	.86
1902	11.62	88.20	.86
1903	12.98	86.52	.86
1904	11.33	87.50	.86
1905	12.12	86.69	.85
1906	12.41	86.32	.85
1907	12.04	86.61	.83
1908	12.44	86.62	.84
1909	12.71	85.78	.87
1910	13.44	85.83	.94
1911	13.01	85.75	.91
1912	12.79	85.75	.94
1913	13.51	85.48	.95
1914	12.80	85.00	.90
1915	12.50	86.00	.94
1916	13.52	85.00	.99
1917	13.40	85.90	1.07

They had been working on ores which caused very little inconvenience, the metallic contents running high with small variations, and we find in parallel the use of all facilities that may have been at hand to give good tonnages, coke practice, and general efficiency. This period continued until we have the climax, in the big production of the Duquesne, the Edgar Thomson, and the Illinois Steel Company furnaces. (These are named because they are most generally known.)

From 1905 and for the next five years there is a quick

change in the physical characteristics of the materials used. Coke for the most of the furnaces was made from coal that was not quite as good as that of the old Connells-ville basin. As a rule it was soft, small, and carrying lower fixed carbon and higher ash.

The Mesabi ores were mixed in higher and higher percentages. The physical properties of these ores changed from a fairly coarse mixture to one that might carry 15% through the 100 Mesh Sieve.

This variation in material naturally required different methods of operation. Irregularities developed which led to a great decline in the efficiencies attained by the representative plants of the country. Many of us are familiar with this decline and it was emphasized by low tonnages, high coke consumption, greater losses, and the attending troubles incidental to irregularity of furnace operations.

The most pronounced changes were the lowering of the blast temperatures, more irregular movement of the furnace, higher flue dust production, a large amount of accidents, high coke consumption, etc. This period would show an attempt to overcome lower production by increasing the blast volumes, which in itself is liable to counteract the best results that may have been obtained under certain conditions. Attending this high wind usage we find a quicker deterioration of furnace lines which in itself only accelerates bad practice.

In the meantime the consumption of Mesabi ores rose in some representative companies from 59% to 81%. In some cases and for short periods this rose to 95%.

TABLE SHOWING MESABI INCREASE OF A REPRESENTATIVE COMPANY

1907	59.5
1908	59.4
1909	63.
1910	71.4
1911	62.4
1912	55.6
1913	61.
1914	65.4
1915	71.6
1916	74.5
1917	81.9

The mere tabulation of sieve tests of percentages of Mesabi used would be a small part of the actual physical change that took place. Criticisms of like nature may be applied to what was also termed "Old Range Ore." It became very different in texture, as the separate seasons opened up; no longer did we have the lumpy ores of years gone.

From 1905 to approximately 1910 we find no lasting development which called for any upward turn to better general results, with possibly the exception of an odd furnace here and there. In the year of 1910 a marked change was made in the development of the hearth diameter, as for instance, the blast furnaces of the South Chicago plant of the United States Steel Corporation. With permanent results being accomplished, it blazed the way to apparent better efficiencies.

About this time we also find a systematic campaign going on for a betterment of the fuel and fluxes used in the blast furnaces. This move in itself means quite a lot of time and study, and should be given due credit. These developments gradually spread through the corporation's plants, and later through the line of independent furnaces, making all grades of irons.

It can be noticed that as furnace operations commence to be smoothened out, we find large tonnages, small losses, gradual lowering of the coke consumption, and particularly the use of higher hot blast temperatures at the representative larger plants. In a great many cases these heats rose from 750° F. to 1100° F. average temperature lines. Any one acquainted with these different developments knows the difficulties that attended this progression. The production of flue dust decreased from around 500 pounds to approximately 200 pounds per ton of metal, showing much smoother operations. This turn in the development came to a climax in the year 1915-16, where we find supporting the country's output of steel, a phenomenal blast furnace operation at quite a number of plants, showing an average line of increased production, lower coke

practice, etc., for the country at large. The highest of these average lines for the year were obtained at a number of plants as can be noted from table following:

<i>Plant</i>	<i>No. of Furnaces</i>	<i>Aver. Tons Daily for the Year</i>	<i>Coke Consumption</i>
1	11	539	1854
2	1 (2 fcs. in group)	608	
3	4	535	1867
4	4	526	2197

All these plants worked on a different kind of coke, fixed carbon, etc. The rounding out of these developments in most cases is all the more interesting because they were accomplished when using material that in former years gave only ordinary practice, and one will have to study what change took place in furnace design to make any conclusions.

Since the year 1917 the furnaces of the country have been so upset by irregular operations, material, etc., that this time should not be taken into consideration.

DEVELOPMENT OF FURNACE LINES DURING THE PAST TEN OR TWELVE YEARS.

In going into the analysis of what may have likely aided this increase, the subject of the development of the lines of the furnace with attending influences is interesting and broad.

The subject will be divided into four general classifications:

1. What has been the development of the furnace lines. Thickness of the brick work, and how the lines are maintained above the mantle.

2. Special study of the increased diameter of hearths, steeper angles in the bosh, how the bosh is maintained, showing results.

3. How has the change of bosh influenced the carrying of hot blast temperature?

4. Discussion on how material of inferior quality, both chemically and physically, is being used, and what results are being obtained.

The term "Lines" of a blast furnace is commonly understood to be the internal shaping of the brick work, expressed in dimensions of feet, inches, degrees of angles, etc., and is the bounding line of brick work, etc., called linings. We should divide the lines of the furnace into sections of the heights, which may be termed:

1. The Throat,
2. The Middle Section,
3. The Bosh,
4. The Hearth.

These sections are subjected to different degrees of heat and wear, and are constructed differently in order to suit the best purpose. Before entering into results obtained in any furnace it is well that we should study the details of these parts for shape, size, method of holding, etc.

I. THE THROAT.

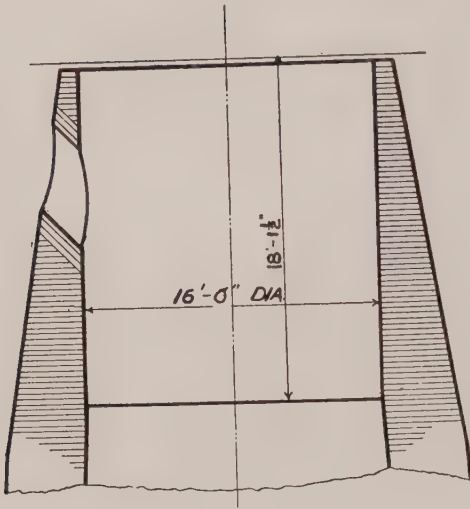
Starting at the top of the furnace we encounter a section that is subject to a comparatively low heat, but is given rough usage, due to the abrasion of material first coming in contact with the brick work, and being deflected to move in a vertical plane downward. In the large furnaces of the steel making plants this would likely appear as shown on sketch No. 1.

For years there has been no great variation in the shape or size of this part of the lines. Its protection is one of greater interest.

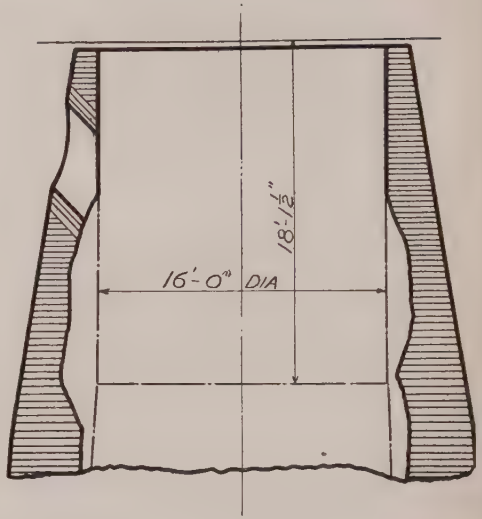
FORMS OF PROTECTION OF STOCK LINES.

Some furnaces are built without any protection, the brick being held firmly together with a small percentage of cement, and good results have been obtained.

Sketch No. 2 is a section of the upper wall of a furnace which produced 670,000 tons of metal, with a coke consumption of 1925 pounds per ton of metal, with no renewal of walls. Some furnace plants renew these during the



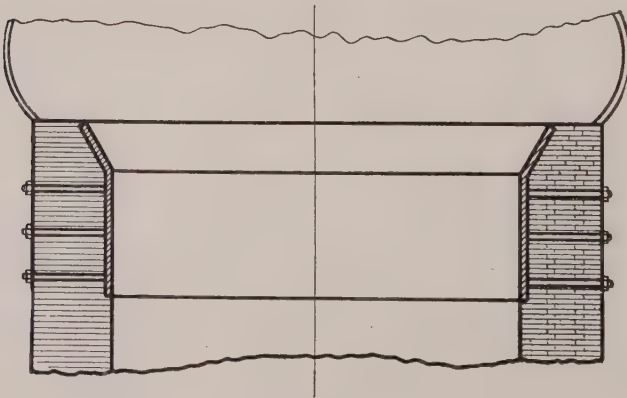
Sketch 1



Sketch 2

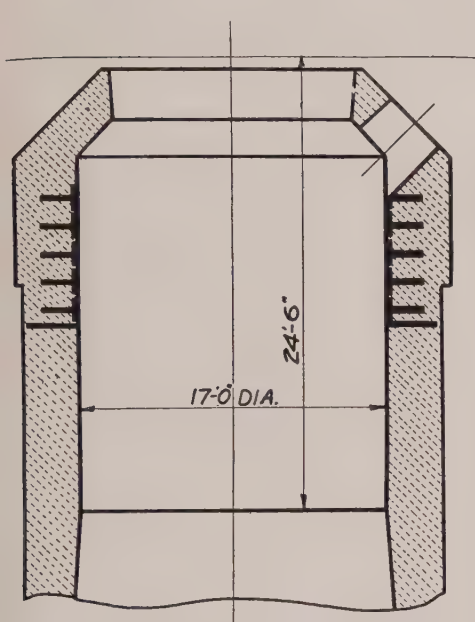
campaign, others find it gives good results for quite a length of time.

On sketch No. 3 there is shown a successful method employed by some of the large plants of the country. It consists of steel sections tied back to the shell.

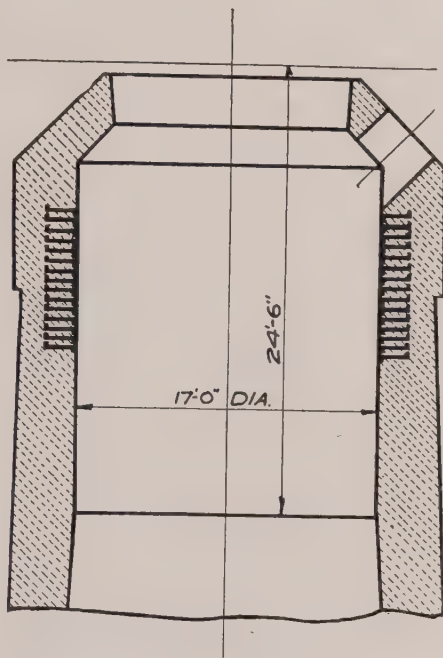


Sketch 3

Sketch No. 4 is one of the most common designs of stock line protection, and consists of cast iron sections imbedded directly in the brick work. In practice, if they are put in correctly, their life is as long as that of the average lining.



Sketch 4



Sketch 5

Sketch No. 5 shows a method that also has given good results, and consists of steel bands embedded in the brick work.

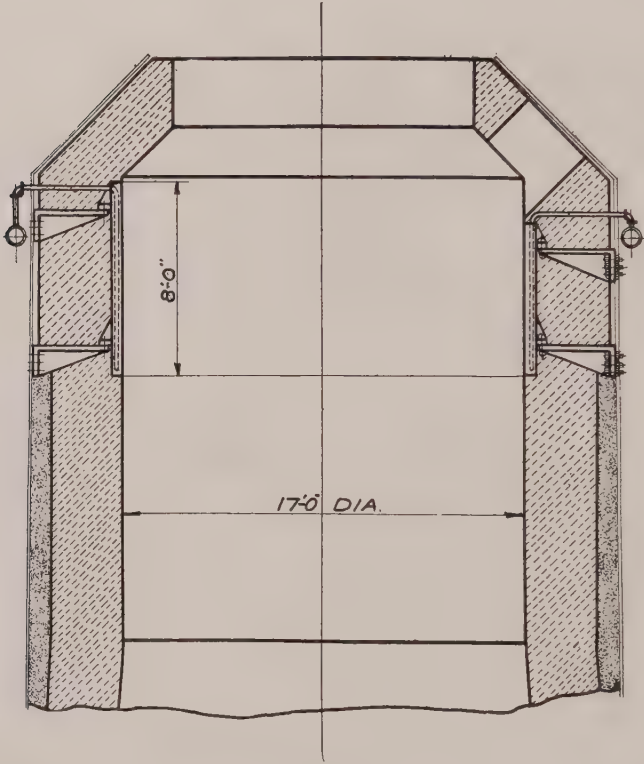
In both methods Nos. 4 and 5 it is necessary that perfect bonding be made with the refractory brick in order to hold.

The loss is quickly felt around this section, in case something is misplaced.

These protection plates are variable for different distances above and below the stock line level. If they are placed too far below they may go rather early in the campaign, owing to some local heat action which would

destroy them. It should be borne in mind that irrespective of the distance protected by them, the brick wall will cut away badly just below the points unprotected.

Sketch No. 6 shows large cast iron or steel sections



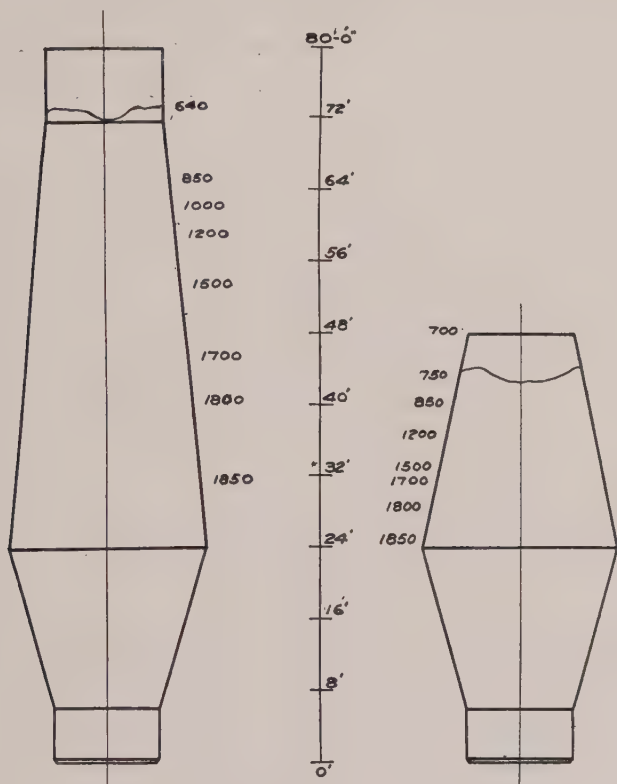
Sketch 6

with water pipe inserts. Their use is not general but they have given very good results.

Stock line protection is of the highest importance and unless we maintain a definite shape, bad work is experienced at all times, but when it is maintained properly, good practice can be gotten, even though other parts of the lining may show great weakness. Too much stress cannot be placed upon a proper protection.

II. THE MIDDLE SECTION.

In the period of large blast volumes a rapid deterioration of the middle parts of the refractory lining causes considerable effort to be made in the holding out for



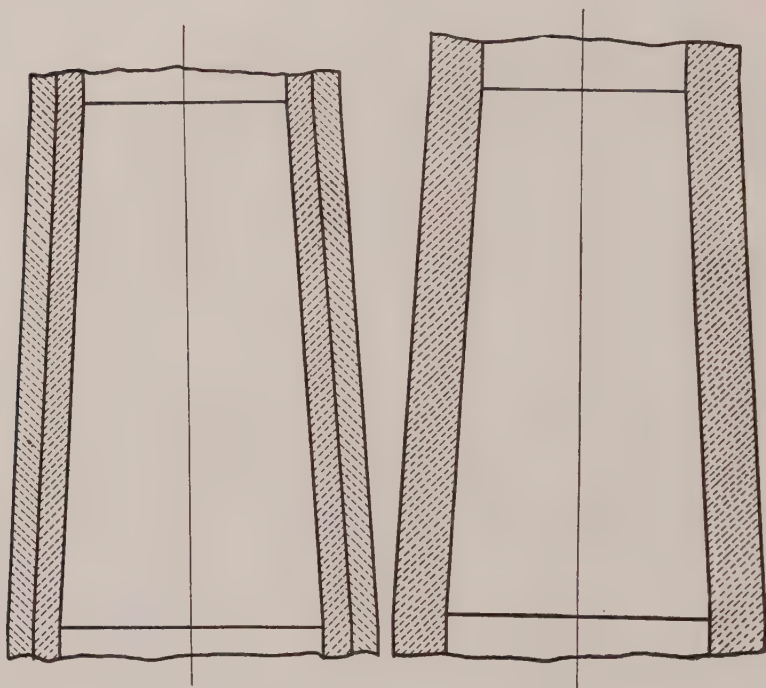
Sketch 7

longer life of lining. This brought about several modifications in the way of cooling above bosh lines.

The wide difference in the construction of a blast furnace comes at a line known as the bosh, and is a point in the temperature scale of the whole process where there is a change in the state of the materials.

This in mathematical measurements is approximately twelve to fourteen feet above the point of the blast en-

trance, and on analysis appears to be the same in all furnaces of different sizes and dimensions. Here we find a fairly high degree of heat given by most authorities, and substantiated by rough checking to be somewhere between 1850 and 2000° F. This degree of heat causes but little



Sketch 8

Sketch 9

change in the physical state of the materials charged, only a slight softening. One is inclined to think in ordinary working condition there should be but little fusion at this point. When there is a fusion it makes its appearance in the form of the furnace hanging up. This degree of heat would not ordinarily injure any of the refractory materials used in construction. However, this middle section is subjected to such an erosion, chemical reaction pressures, and swelling of the charge, that it is quite independent of so moderate a temperature. The wearing away of the refractories is proportionate in all heights

of furnaces, and follows the chemical changes closely.

Sketch No. 7 is taken from the works of L. Bell, and the early investigations of this observer remain unrefuted.

Before 1905 the average brick work in most steel works blast furnaces approached closely to sixty inches at the mantle and was constructed sometimes in two walls, as shown in Sketch No. 8,

This was later changed to a method as shown in Sketch No. 9.

About this period there were some remarkable tonnage records turned out on the lining life, with fair coke results, although efficient coke practice was no doubt sacrificed for longer tonnage records. Some of the large tonnages produced on these lines would read as follows:

Plant No. 1.....	1,296,000 Tons
Plant No. 2.....	1,202,000 Tons
Plant No. 3.....	1,250,000 Tons
Plant No. 4.....	1,327,000 Tons

This was following closely after the English practice of very thick walls, but a more rapid driving coupled with the finer Mesabi ores caused the thick walls to be gutted badly.

Also a saving was attempted on refractories by the grinding of old material when making brick for the new linings. All these resulted in more frequent periods of tearing out and rebuilding, the idle time percentage was considerably increased. In the tearing out of the thick walls it was noticed that a large percentage of the brick was still good.

A composite drawing of the worn out lines of a furnace of this period would probably look like Sketch No. 10.

THIN LINED BLAST FURNACE.

About 1906 the thin lined blast furnace made its appearance from Europe. Great results were anticipated for it in the reduction of the time necessary for the re-lining period, and with the hope that by cooling the surface, the blast period would be indefinitely prolonged. It

was also thought that this lining could be subjected to conditions of operations which were impossible with the thick lining. Visions were had of its being made to make large tonnages, and constant coke practice.



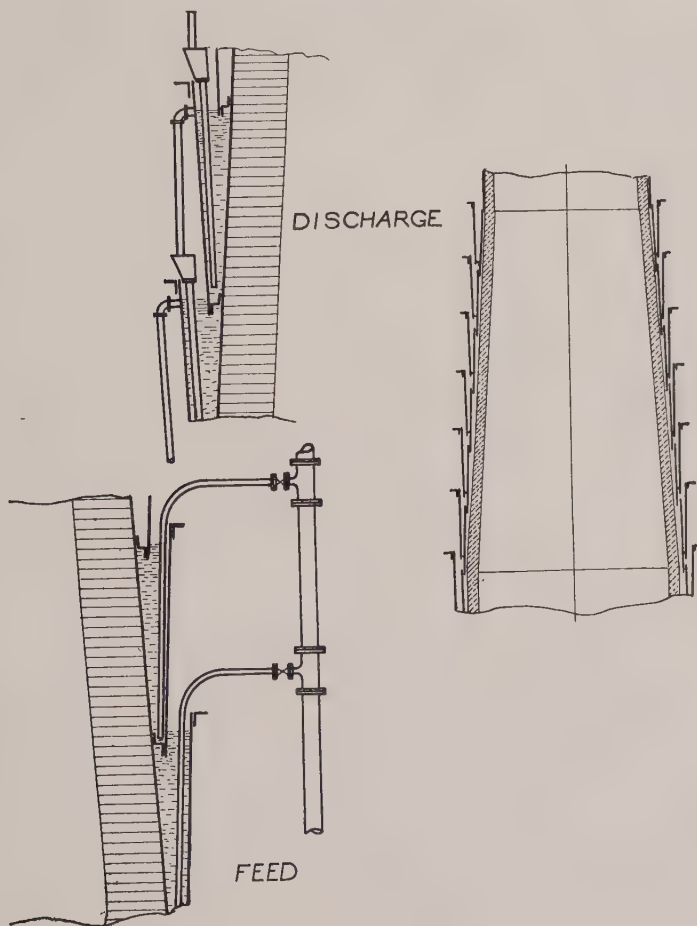
Sketch 10

The United States Steel Corporation, showing its usual method of progression, had these furnaces built in four districts in order to get the different results under different forms of management, material, and operating conditions.

In each case the brick was fitted tightly against the steel shell, the outside of this shell being cooled with water.

Sketches Nos. 11 and 12, will illustrate methods of construction:

Sketch No. 11, shows rolled steel sheets riveted together and buckets fastened to the shell, the water for cooling overflowing from one line of buckets to those below. This was the early type.

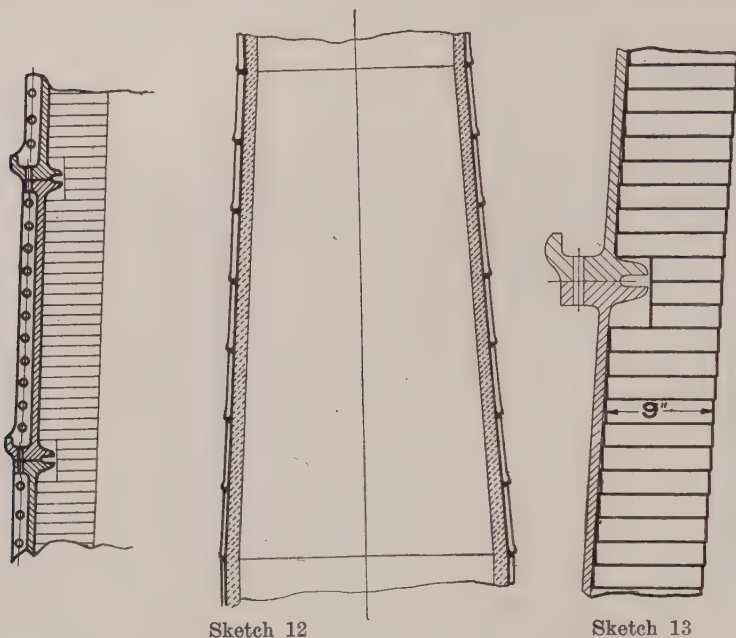


Sketch 11

Sketch No. 12, shows cast steel sections bolted together, with water running all the way from the top to the bottom of the furnace, and was tried out only at one point. It is still in use with only slight changes.

The experiences of the operating people with these thin lines were many. The greatest difficulty being en-

countered in keeping the water from going into the furnace. Quite a number of these irregularities were overcome from time to time.



THIN LINED FURNACE WITH 9" BRICK WORK.

Sketch No. 13 shows a single nine inch brick used with a thin clay as a binder, butted tightly against the shell, and could be constructed in a very short space of time, it being a matter of simply laying the brick in, very little cutting or chipping was necessary.

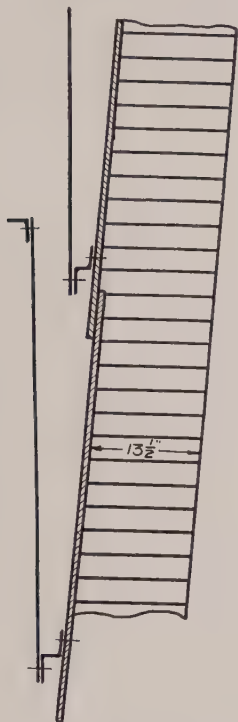
The data following will show some of the work of these lines:

Plant	Campaign	Tons Per Day	Total Production	Coke Per Ton of Metal
1	1	435	175,000	1948
1	2	418	218,000	2161

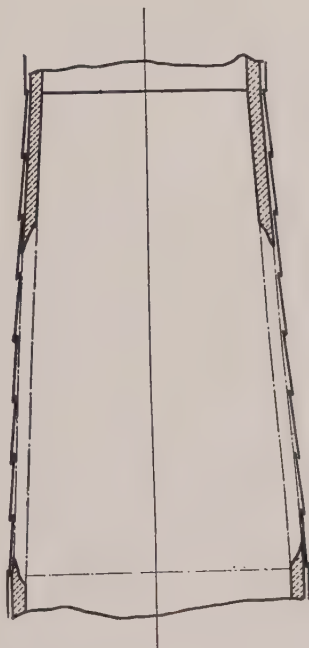
In the thickness of brick the life was found to be too short for a commercial proposition, owing to the fact that some other sections of the furnace were expensive, and took time to rebuild. Practically all these furnaces have since been relined with slightly thicker brick work.

THIN LINED FURNACE WITH $13\frac{1}{2}$ " BRICK WORK.

Sketch No. 14 shows the thirteen and one-half inches of brick work which was next used, laid in thin clay and



Sketch 14



Sketch 15

butted against the shell. By increasing this thickness four and one-half inches better results were at once obtained, and operations were smoother, for a longer period.

Some data on these lines would read as follows:

<i>Plant</i>	<i>Campaign</i>	<i>Tons Per Day</i>	<i>Total Production</i>	<i>Coke Per Ton of Metal</i>
1	1	500	299,000	1954
1	2	481	243,000	2136
1	3	526	454,000	1934
2	1	531	295,000	2076
2	2	497	217,000	2111
2	3	522	222,000	2050
2	4	500	200,000	2144

At plant No. 1, the tonnage gained on the increased thickness of four and one-half inches of brick work was

136,000 tons, and the average coke consumption throughout the lining life was also better.

It should, however, be noted that the nine inch lining had to suffer for all the mistakes made in construction. The thirteen and one-half inch lining following, necessarily profited by these corrections. Some of these construction difficulties were interesting, and were seen in the form of cracking of the middle section, cracking of the shell even with water held against it, as in the bucket type.

At first angles were also used to support the brick work, these being done away with at some places.

This type of furnace was thought to be particularly adapted to the making of Ferro Manganese, Ferro Silicon, Spiegels, and other high coke irons. They lasted fairly well in this work, but did nothing to uphold any unusual claims. As a rule they would be blown out on account of too much water getting into the stacks. It was noted that these furnaces first became weak in the same relative position as the thick lines.

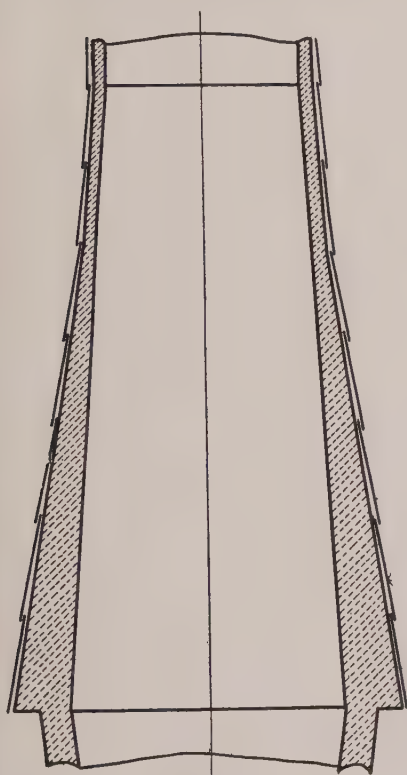
Sketch No. 15 will show brick comparatively good, thirty feet down, after the furnace had produced over 230,000 tons, and was blown out on account of too much water getting into the stack.

It is interesting to compare the work of these furnaces for certain periods, with thick lines, under the same management, and it is observed that while the thin lines were in fair shape the work was almost equal.

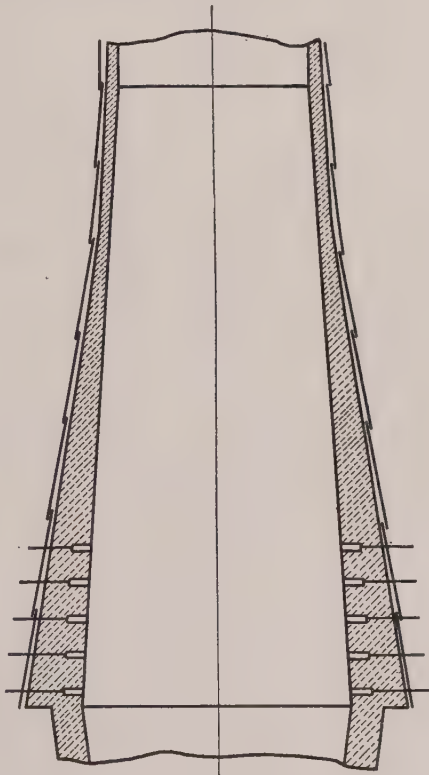
The following table shows thin lined furnaces compared with others in the same group, during period of runs:

<i>Plant</i>	<i>Furnace</i>	<i>Thickness of Wall</i>	<i>Average Daily Tonnage Per Year</i>	<i>Coke Consumption Per Ton of Iron</i>
1	1	Thick Wall	533	2056
1	2	Thick Wall	535	2010
1	3	13½"	510	2095
			(Monthly Run)	(Monthly Run)
2	1	Thick Wall	543	1702
2	2	Thick Wall	545	1742
2	3	13½"	537	1904
2	4	Thick Wall	567	1820

The general comment on these furnaces is that there have been none erected in the last few years. This is in spite of the small sum necessary to cover cost of relining, and idle time having been reduced to as low as two weeks between blasts. Those concerned in their operations have favored somewhat thicker lines. Several of this type will be modified, as shown in Sketches Nos. 16 and 17.



Sketch 16



Sketch 17

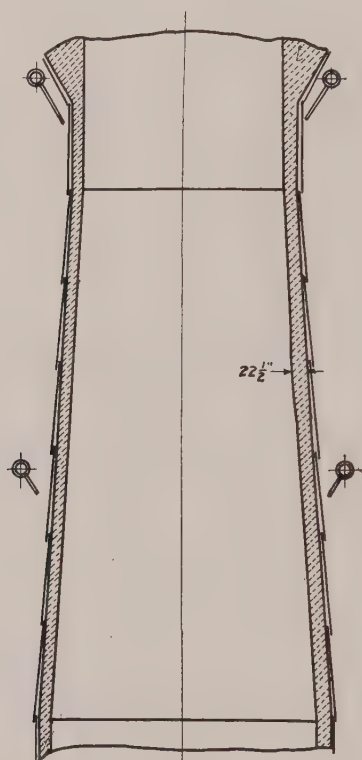
The method of Sketch No. 16 should prolong the life of the lining, up to theoretical estimations, of 600,000 tons.

The most serious objections to the construction of the thin lined blast furnace is that once we have the heavily constructed shell the lining cannot be altered quickly, unless a considerable time is taken to remodel the shell in some manner. If it were found practical to assemble

other parts of the lining as quickly as is done the section from the mantle upward, there would still be high hopes entertained of the thin lined blast furnace.

TWENTY-TWO AND ONE-HALF INCH LINING.

With the experience obtained on the thin lined furnaces of nine, and thirteen and one-half inches of brick



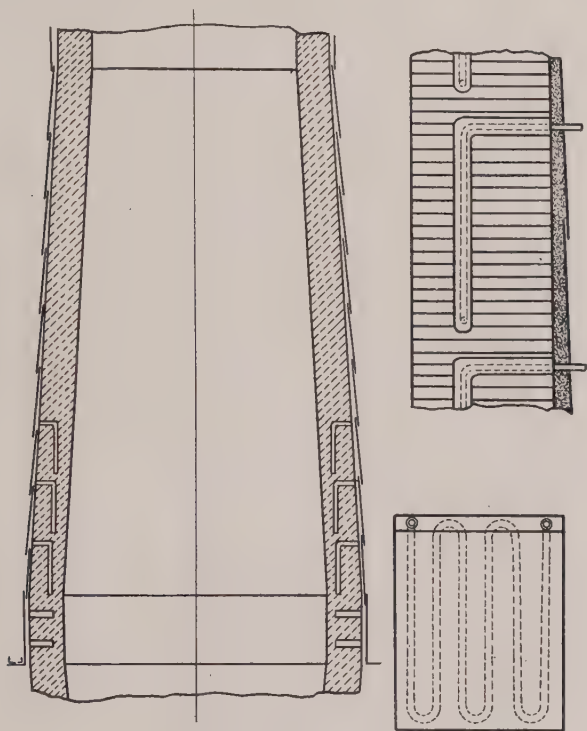
Sketch 18

work, there have developed modifications which call for lining, twenty-two and one-half inches in thickness, made in two bricks, butted tightly against the steel shell, and sprayed with water when necessary.

This construction can be noted on Sketch No. 18.

An accurate measurement of the wear was taken on this furnace after it had produced 220,000 tons of metal,

it being out of blast on account of no demand for the product. It was found that the lining had only worked back a few inches, and it was put back into blast after standing two years, and has produced to date 530,000 tons of iron.



COOLING PLATE

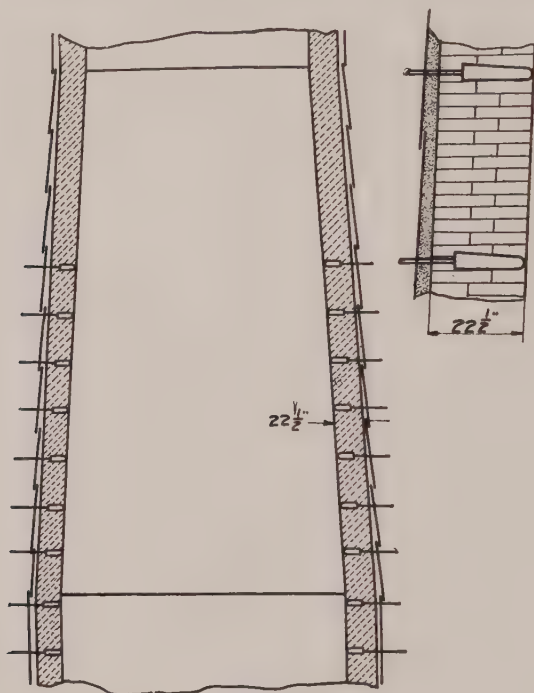
Sketch 19

Its record during this period compared most favorably with the thicker lined furnaces of the same group, no trouble being experienced with the shell taking water, etc.

However, similar comments can be made on the twenty-two and one-half inch lining, as was noted on the other thin lines; that is, the lining cannot be changed widely from what is originally planned, unless it is decided to make the volume smaller.

COOLING BY PLATES INSERTED IN THE LINING.

We now turn to another form of holding the lining above the mantle section. In this method cooling plates are securely buried in the brick work of different thicknesses, and are usually in position for the lining's life. The methods of insertion and distribution over the stack area vary widely. Their usage has in a good many cases



Sketch 20

reduced the thickness of the brick lining. In other cases, however, we find that the lining is made as thick as formerly.

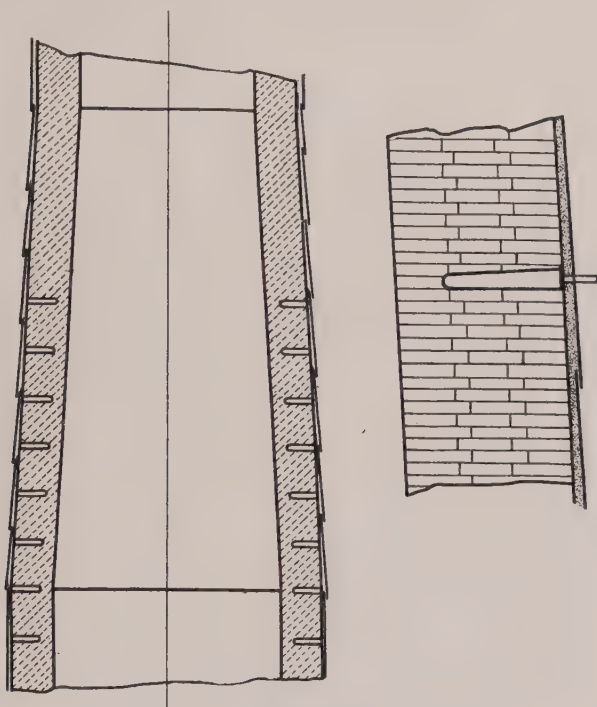
"L" TYPE COOLING PLATES IN 31 1/2" LINING.

This is usually a large cast iron plate, with coils of pipe embedded. Sketch No. 19 will give the method of construction.

This method has not been used very extensively, but

in the plant where its service has been continual we have the following data:

<i>Furnace</i>	<i>Daily Average Production for Year</i>	<i>Coke Consumption Per Ton for Year</i>	<i>Total Tons Produced</i>
1	518	2112	783,500
2	518 $\frac{6}{10}$	2128	701,667



Sketch 21

22 $\frac{1}{2}$ " LINING WITH BRONZE COOLING PLATES PLACED FLUSH WITH FACE OF THE BRICK WORK. SKETCH No. 20.

This method of protection is used in a few places. Results experienced do not give the best efficiencies, nor was there any great extended life of blast by the use of this method.

36" LINING WITH BRONZE COOLING PLATES. SKETCH No. 21.

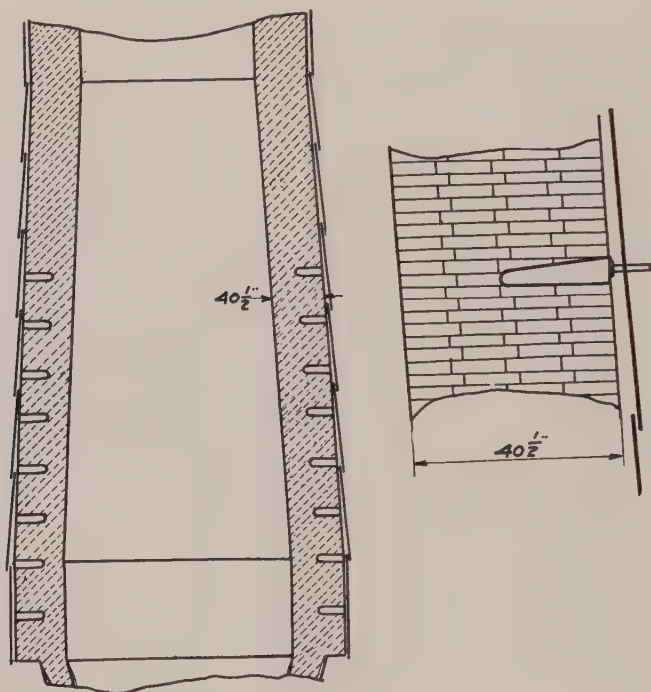
This method is sometimes used with the plates flush with the edge of the lining, and in other cases placed a few

inches back. We know of cases where this has made 800,000 tons of very fair practice.

40½" LINING WITH BRONZE COOLING PLATES.

SKETCH No. 22.

This thickness of lining is a little more popular than some of the others mentioned, and has given good results.



Sketch 22

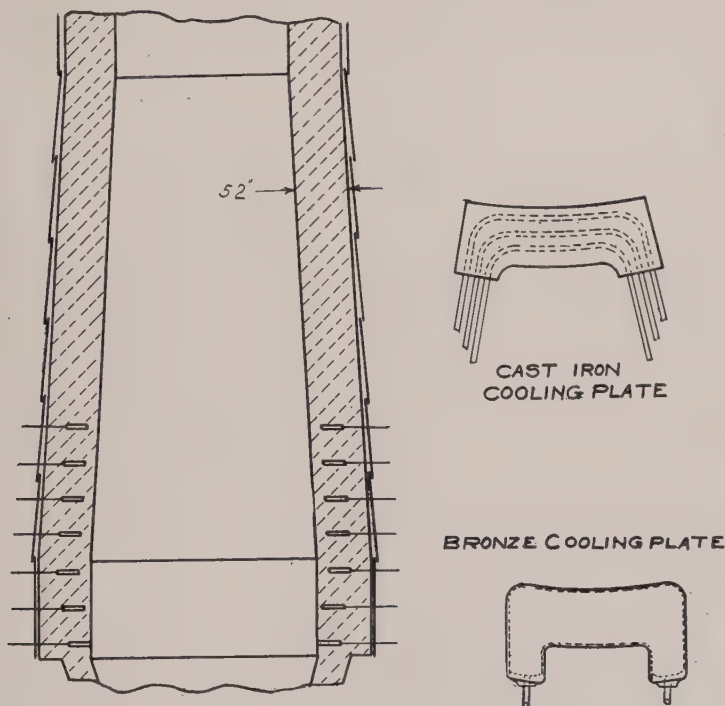
In most of the cases we find that the plates have been placed back of the face of the lining. Some average results on this type of lining are shown in the following table:

<i>Furnace</i>	<i>Average Daily Tonnage Per Year</i>	<i>Total Tons on Lining</i>
1	530	559,000
2	507	498,000

Some low coke and good tonnage figures have been obtained with these lines.

52" LINING WITH BRONZE PLATES. SKETCH No. 23.

This is the most popular of all lining cooling by the plate method, and we find that as much as twenty-two inches of brick work is in front of the plates. The work



Sketch 23

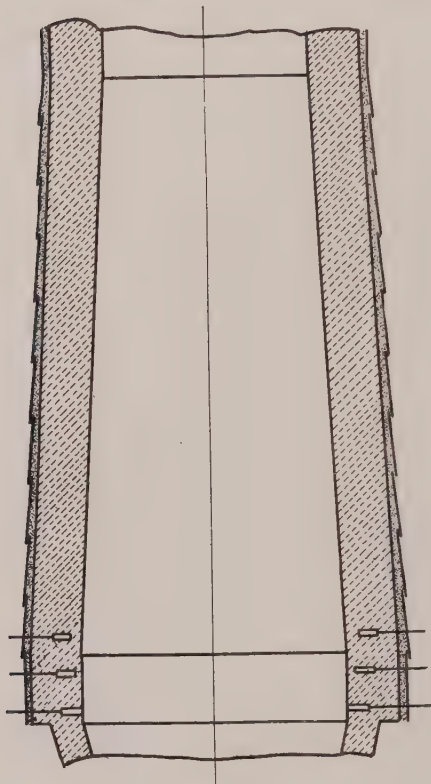
of these furnaces would be typical, as shown in table following:

Plant	Furnace	Best Daily Production for Mo.	Tons Produced on Lin. at This Period	Coke Consumption on That Tonnage
1	1	567	100,000	1904
1	2	520		1942
2	1	669	600,000	

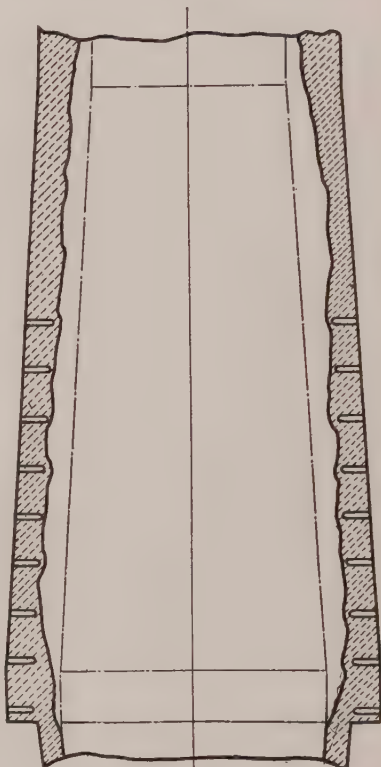
It is very clearly demonstrated that the placing of the plates back from the face of the brick work adds very much to the smoothness of the working of the furnace. In the plants where this is used, their lining life is extended

considerably. The coke practice is very much influenced toward the end of the lining life.

In place of using bronze plates, as is shown by the foregoing sketches, cast iron coolers with pipe inserts



Sketch 24



Sketch 25

have been used. They have not been as successful as the bronze effect, however, it being noted that they burn away much quicker, and cause more irregularity of the working of the furnace, after being in blast for a time.

Quite a number of places have not carried this cooling to any extent, as noted in some of the other sketches, but preferred to give only a small cooling space, a few feet above the mantle, as can be noted in Sketch No. 24.

This has not been of much advantage as far as we

know, owing to the fact that this lower part, cooled by these plates, does not give way nearly so frequently as the other parts of the lining.

In some cases this arrangement caused trouble, where the coolers failed during the early part of the campaign, and had to be abandoned.

Although the cast iron coolers are much cheaper, there is no comparison in the results obtained when using the bronze, owing to the fact that very few bronze plates are apt to fail.

Where plates have been used for prevention of wearing in the upper lining, the most successful campaigns have been experienced with the plates set back from the face of the lining at the time the furnace was blown in. The wearing away of the lining between the cooling plates becomes very irregular towards the last part of the blowing.

Sketch No. 25 will show a composite drawing from several blow-outs.

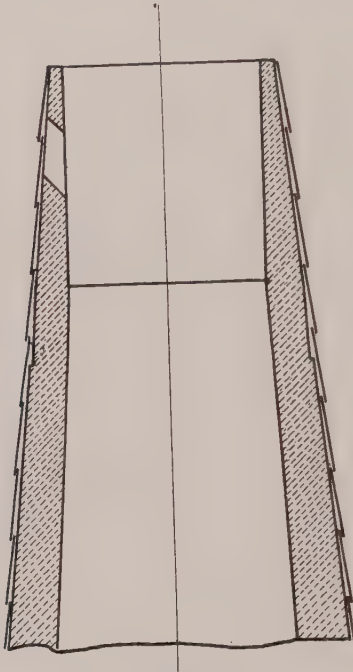
Furnaces of this type work very irregularly when old. The general comment on this style of operation is that as a whole this type of furnace has not produced the highest daily tonnage, nor the lowest coke consumption, but they show some very long lining periods. It is questionable how long a furnace should run for the best of efficiencies, because an extended lining life may not always mean the best results that are possible.

UNPROTECTED LINES.

With the returning of relatively lower blast volumes we find good tonnages, and longer lining records being made on thinner lines, with no cooling. A thirty-one and one-half inch lining is still in use and has produced 506,000 tons of iron. There are also official records of linings, 36", 40½", 42" and 45", that have all produced above 500,000 tons of iron, and are still running.

In looking over the records of linings, we find that an unprotected wall of fifty-two inches at the mantle is used

quite extensively. Very often in blowing out these linings are only weak at the stock line and the middle section. This type of furnace has produced most of the records made during the last few years on coke consumption, tonnages, etc.



Sketch 26

From a study of the worn-out lines there is no question that the thickness of brick work could be reduced at different parts of the stack. This in itself means a labor saving, and idle time would be cut down when replacing.

Sketch No. 26 shows a type of lining that is thin towards the upper section and has shown good practice.

When tearing out after making 670,000 tons of metal, the brick work was still in very fair shape. It can be noted also that this brick work is butted direct against the shell, so as to aid radiation or cooling effect. The large packing space between the brick work and the steel shell may be one of custom, rather than need, as there are

only a few shell failures out of the large number in use, and these failures occur chiefly on shells that are very old.

The added radiation introduced by having the brick work butted against the shell should produce a longer life of the lining, and it becomes of no purpose to insulate the brick work of the stack, owing to the fact that the internal chemical action, etc., detrimental to the brick work on the inside face of the lining, are retarded by cooling. Also, we have no refractory as yet that would stand up without being cooled on some surface. If this were before us, forty inches of brick work would last as long as the lining would do efficient work, owing to the fact that if the lines were to wear as large as the brick work would allow, the furnace would no doubt be giving considerable trouble.

It is problematical as to what tonnage should be gotten out of a lining, and the average of a series of campaigns is the best rule to use. We know that cases arise where the lining seems to be in good shape for an indefinite period, and others made from the same quality of material, go quickly. At least 500,000 tons of good practice should be gotten out of the average forty-inch lining.

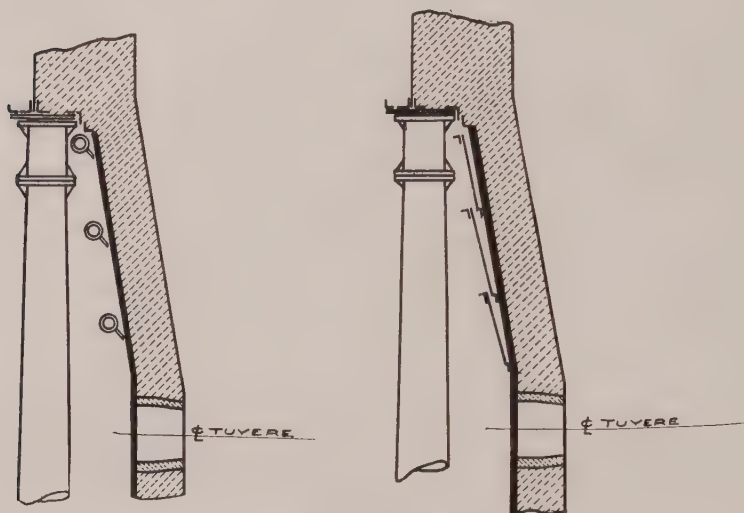
Manufacturers of refractories are making great efforts to produce good results, and it is hoped that their researches will lead to a combination of materials that will give longer wearing qualities. There have been some very fair records gotten during this last high production period, the average lining lasting as long as was ever done.

III. THE BOSH SECTION.

Below the mantle section there is a sudden change of the state of the materials, caused by the rapidly increasing temperature, the mixtures becoming soft, semi-liquid, and producing great pressure and wear.

These temperatures, etc., are sufficiently high to cause a complete fluxing or melting of any refractories ordi-

narily used. Air cooling alone will not fill the requirements. This has been overcome through years of experimentation by introducing systems of water cooling, which have the effect of maintaining a balanced thickness of walls.



Sketch 27

The inside surface early in the period becomes coated with a conglomeration which maintains a wearing surface that makes up or reduces in thickness, depending on the internal temperature of the furnace conditions.

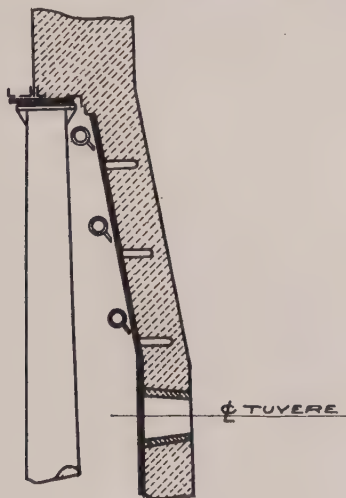
METAL JACKET SPRAYED WITH WATER—SKETCH NO. 27.

This type of cooling is confined mostly to furnaces of relatively smaller sizes. It has been experimented with in the early days on furnaces of larger types, and also tried on the thin lined blast furnaces.

In the furnaces of the magnetic ore regions it is still in use, but has not found favor in the larger type of furnaces used in the steel making plants. It did not work at all well on the thin line furnaces, and had to be abandoned, as no end of trouble was experienced in its operation.

METAL JACKET WITH A FEW COOLING PLATES INSERTED.
SKETCH No. 28.

This type can be sprayed with water when necessary. We find it in current use at plants using a percentage of

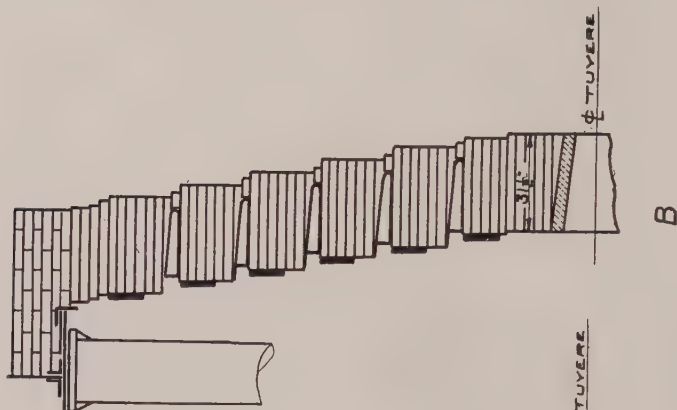
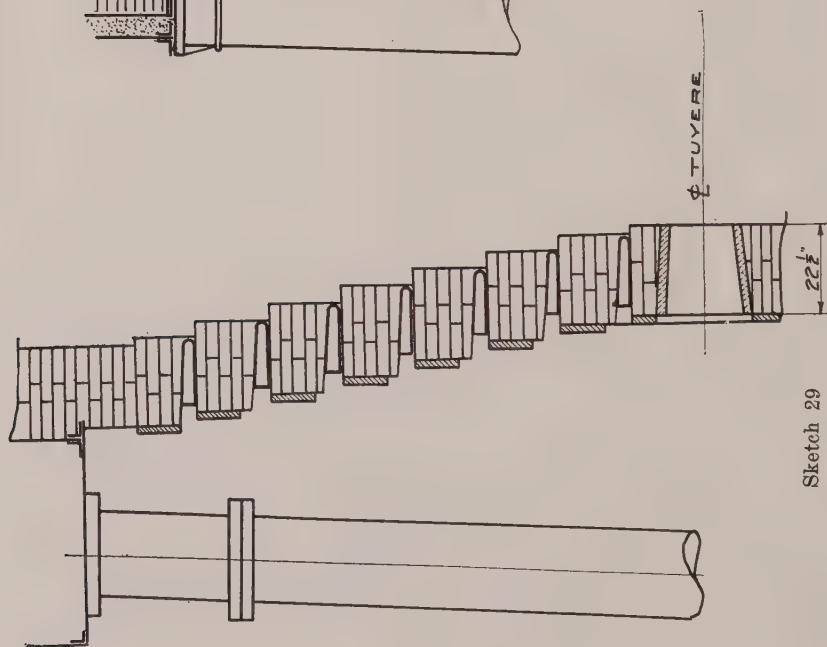


Sketch 28

foreign ores, and the comment from this locality is that its use will be continued.

BRONZE COOLING PLATES INSERTED IN THE BRICK WORK.
SKETCHES No. 29 AND No. 30.

This form of bosh protection is by far the most popular, and its use has covered so many years, that its durability is beyond question. It would be a very difficult matter to offer anything better in lasting qualities, strength and neatness of design than this American type of bosh construction, and its life is quite a bit longer than any other part of the furnace lining. In some places it is not removed when replacing the upper wall of the lining. Its effect in keeping the balanced thickness of walls, and also offering a uniform smooth surface to internal conditions, has been proven to be a condition, that



while not ideal from a thermal standpoint, is the best from a construction point of view.

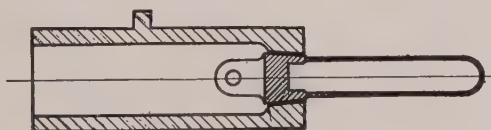
The method of placing the cooling plates vary in different localities, there being differences between the rows, the number of rows, and the covering of the edge of the plates with brick work.

At the same plants where the opportunity has been offered to judge the difference in the working of the furnace, with and without brick in front of the coolers, there is strong indorsement in favor of covering up the edge of the coolers before starting.

The thickness of the brick work using this method of cooling varies from $22\frac{1}{2}$ " to $31\frac{1}{2}$ ".

BRONZE PLATES AND CAST IRON BOXES.

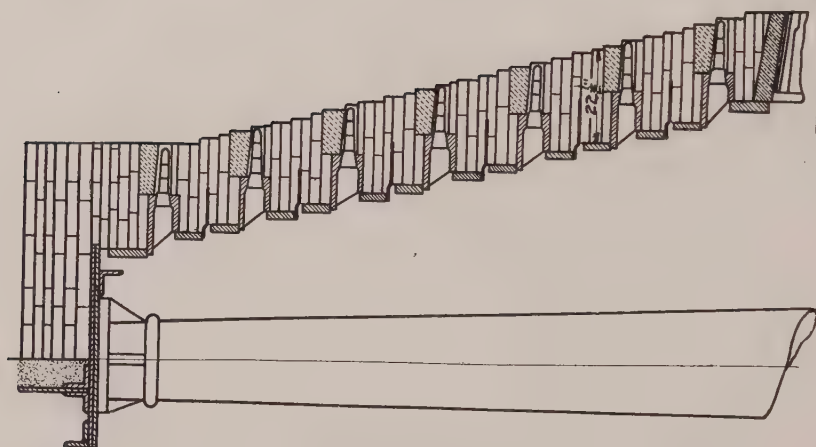
On account of the bronze being costly, and there being an idea that the plates as shown in Sketches Nos. 29 and 30, required a longer time to remove, when necessary, a construction was developed as noted in Sketches Nos. 31, 32, 33 and 34.



Sketch 31

The cast iron boxes or receptacles hold the bronze plates. Air cooling was to aid in holding the lines. This would reduce the cost of the bronze considerably, but it would not make as tight a construction as was noted in Sketches Nos. 29 and 30, there being great tendency to have minor troubles, which are liable to cause stoppage of the furnace. Also the inside surfaces are not held with as smooth a face as was experienced in the sketches before mentioned.

In sketch No. 34 is shown an effort to reduce the cooling with this type of construction, and with the result of

 ϕ TUYERE

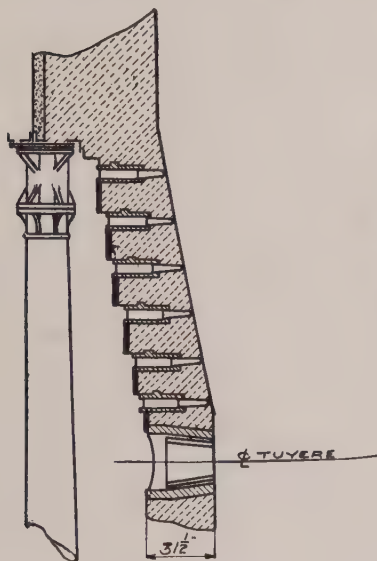
Sketch 32

 ϕ TUYERE

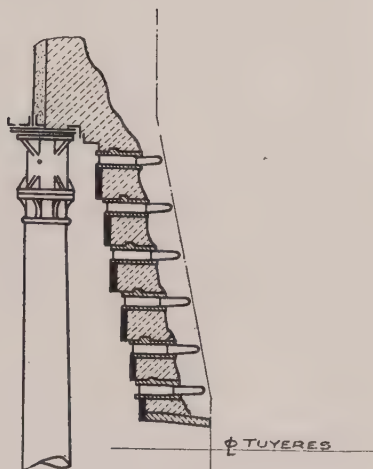
Sketch 33

a weakening of the walls, which were eaten away shortly after being blown in as noted by Sketch No. 35.

This, coupled with bad distribution, caused an undue amount of copper loss, the cast iron boxes becoming so



Sketch 34



Sketch 35

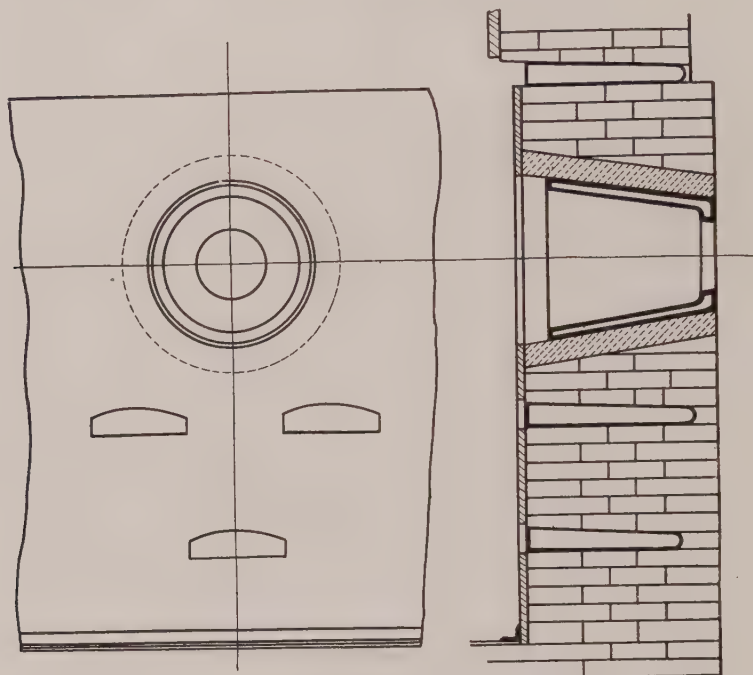
warped that it would be necessary to drive the cooling plates inside the furnace, when they required changing. If perchance, this construction happened to be used with a poorer grade of fuel, further trouble also developed.

In the plants that have the opportunity to compare all classes of bosh construction, Sketches Nos. 29 and 30 are strongly favored, giving better working conditions, lasting longer, and being of neater design.

IV. TUYERE SECTION.

There is offered quite a bit of opportunity to vary the manner in strengthening the bosh at the tuyere section, and it should be born in mind that this area stands the most crucial actions of the furnace. Around this section there is the highest temperature that is attainable in the

whole process. Any effort that is used to skimp on the cost of material around this section usually reflects back to the idle time a furnace may be off on account of minor breakouts.



Sketch 36

Sketches Nos. 36, 37 and 38 will give some variations on the methods of strengthening this section of the furnace lines.

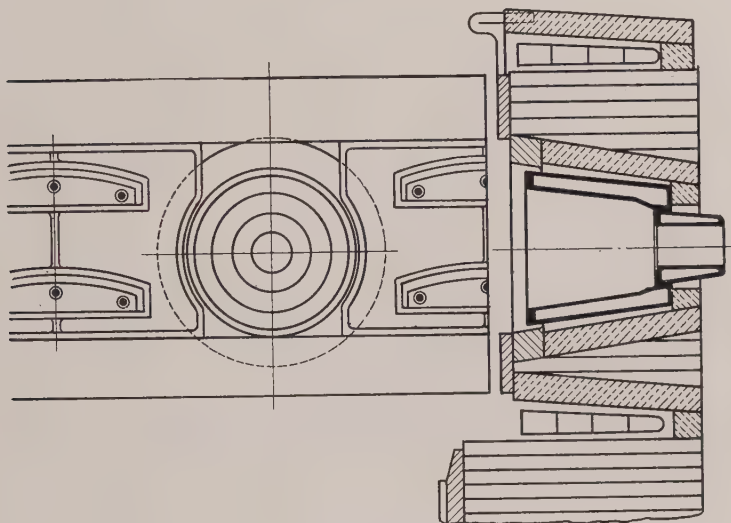
ROLLED STEEL PLATE CONSTRUCTION.

The tuyere coolers are sometimes placed flush with the edge of the brick work, and others are a few inches back at the start of the blowing in.

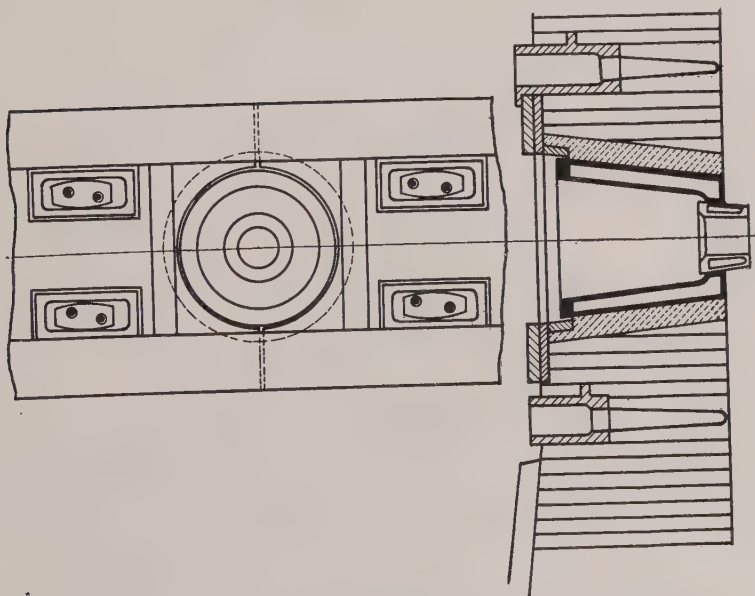
The common section of a tuyere cooler is usually as shown in Sketch No. 39.

The number of tuyere openings, at the modern plants, vary from ten to twelve. The results obtained with twelve tuyeres are no better than those obtained with ten. There

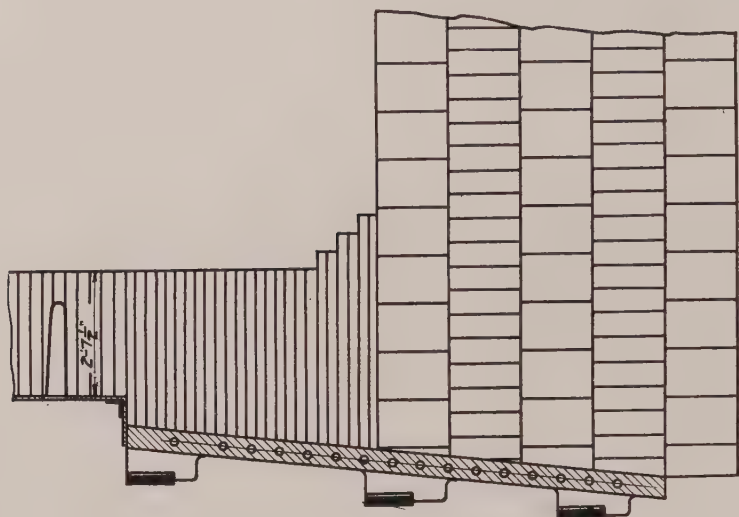
is not a great deal that can be said on this matter to give any conclusions. Sizes of tuyeres used, etc., belong to another discussion.



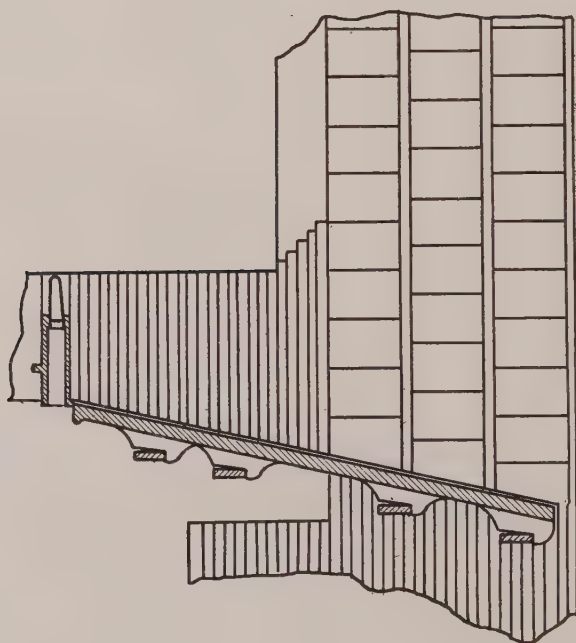
Sketch 37



Sketch 38

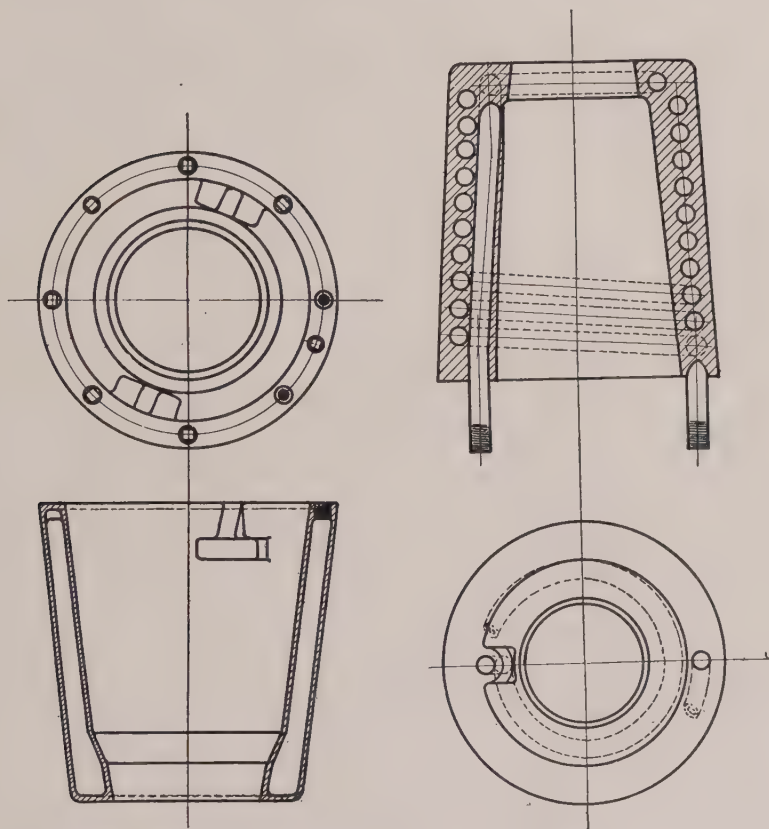


Sketch 41



Sketch 42

The outlet for cinder or slag does not show any wide variation in its distance from the tuyere area, and its protection is usually constructed of a cast iron body with



Sketch 39

Sketch 40

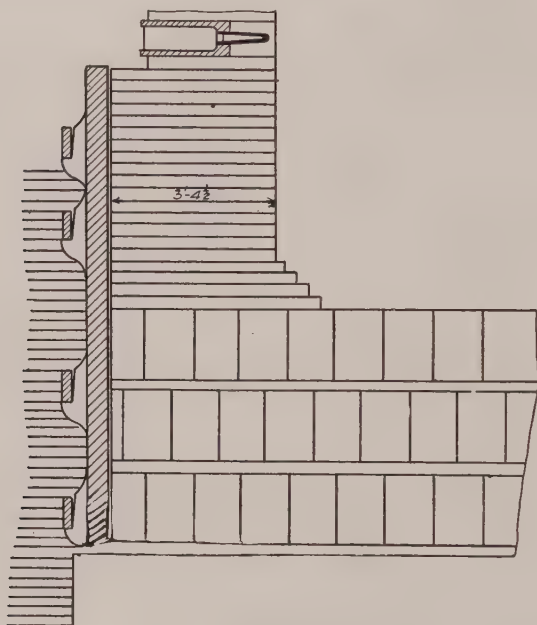
water pipe inserts. Some places prefer to use a bronze cooler, but this does not give any better life, and is more expensive. The height of the cinder notch above the tapping hole varies with the depth of the well or hearth, and is only noticeable on the design of the deep well furnace, there being some comment that the cinder notch can be too high above the tapping hole, in order to give the best results.

Sketch No. 40 shows the iron coolers.

V. HEARTH SECTION.

The hearth section is interesting in the fact that it varies in depth in the larger furnaces, and in its protection.

In a type of large furnaces the hearth is made so that the iron is cast in six hour periods. This holding is



Sketch 43

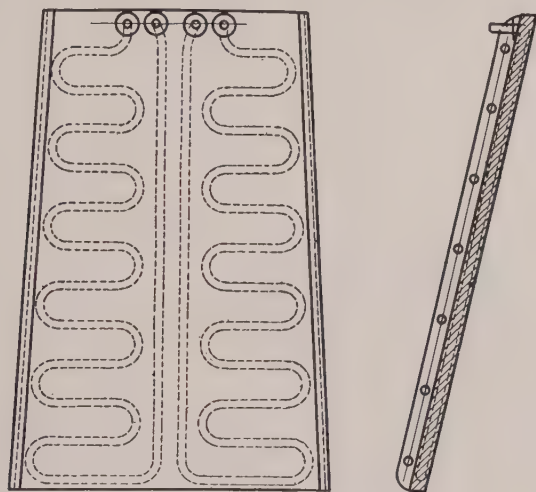
carried on without any serious damage. The larger the hearth, theoretically, should give fewer stops, and more tonnage, caused by the elimination of these stops. If the hearth is too large, there are opinions that it influences the kind and quality of iron that it is possible to make.

The brick work walls of the hearth vary from $22\frac{1}{2}$ " to 60".

Sketches Nos. 41, 42 and 43 show some variations of this.

Owing to the static pressure and erosive actions of the metal and cinder, there should be no tendency to slight

any quantity of brick work. The bottom of the hearth is commonly made of blocks of little larger size than the walls. There have been numerous methods tried to make tighter construction, by shaping the brick, etc., but there is no great claim that can be made for any of these.



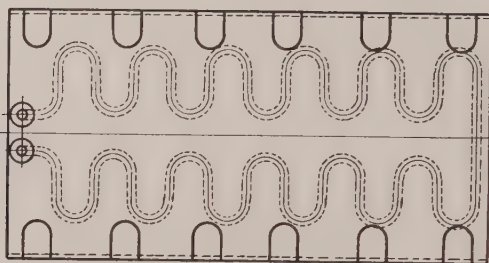
Sketch 44

The protection of hearths known as cooling jackets are of many designs, and can be noted on Sketches Nos. 44, 45, 46 and 47, which are the most commonly used.

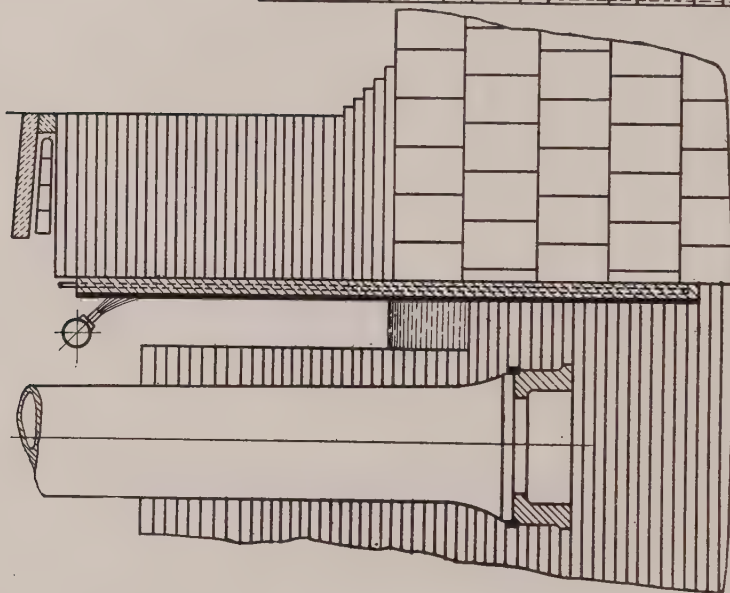
In some plants we find what is known as a subjacket, placed at a slightly lower level. The tight jackets are usually backed up with brick and cement. In spite of long years of study with the best materials and workmanship, hearth trouble still occurs in the way of breakouts. These, however, are handled by so much easier methods than in the old days, that they do not cause such bad losses as were formerly experienced.

DESIGN OF COMPLETE LINES.

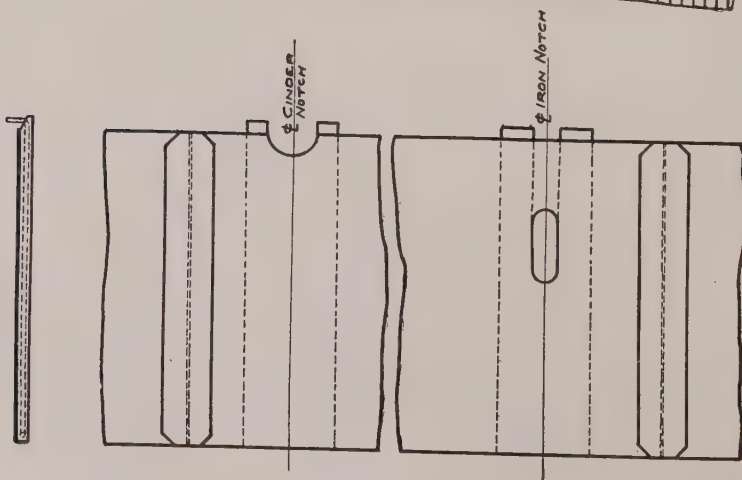
In looking over the drawings of the representative lines of ten years ago, we would find that the average



Sketch 47



Sketch 46



Sketch 45

blast furnace of the steel making companies would be represented by Sketch No. 48.

This type was one of the first to give consistent high production, and varying from this average design, some



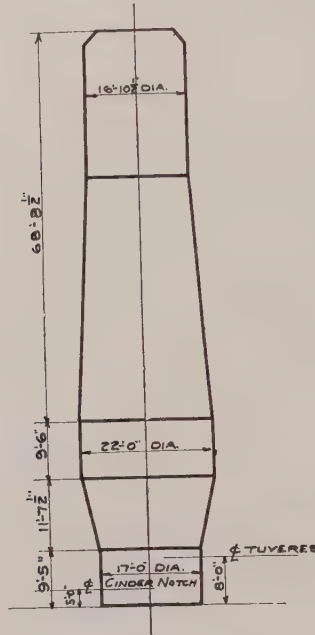
Sketch 48

were made with the boshes twenty-three feet in width, and there was a tendency to make the furnace taller, up to 105 feet.

The operation of these tall furnaces has given satisfaction in the places where used, but the design has not spread very widely.

Sketch No. 49 will show one of the lines of these tall furnaces.

A study of the work is shown in the following table:



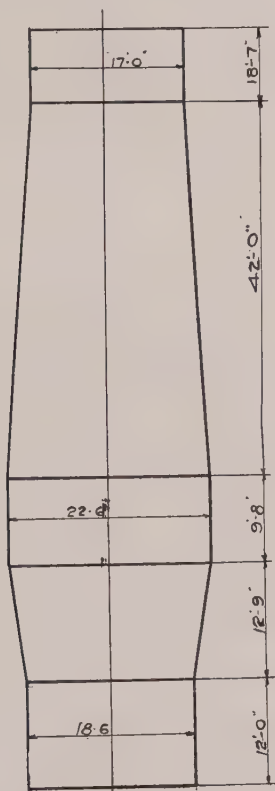
Sketch 49

Date	Plant	Furnace	Height	F. Car.	Average Daily Tonnage	Coke Per Ton of Iron	Estimated Hot Blast Temperature
1917	1	"A"	99-ft.	90	500	1861	1100
1917	2	"A"	105-ft.	89	556	1945	1140
1917	2	"B"	105-ft.	88	533	2065	1030
1917	3	"A"	105-ft.	88	508	2064	890
1917	3	"B"	103-10"	88	486	2072	890

To get another view of the working of these tall furnace designs, would be to compare them with others in the same group of 90 to 95-ft. high, and use as nearly as possible the same material, hot blast temperature, etc. Where such an opportunity has been offered, no great claims have been made for them. It is a safe conclusion that the added heights of 10 to 15-ft. has not been shown to be an idea whereby greater outputs can be obtained, although the taller furnaces work very smoothly.

Sketch No. 50, will show the present lines of a large

furnace of some of the larger steel plants, and it can be noted that there is a great difference in the section below the mantle.



Sketch 50

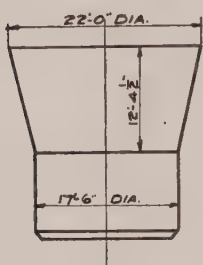
DEVELOPMENT OF WIDER HEARTHS.

Before the year of 1910 a change in the bosh lines was started, a shortening of the distance from the tuyere to the bosh line, widening of the space from wall to wall at the tuyere coolers, thus straightening the angle of the bosh line. At this time a great deal of discussion was aroused over its possible success, as the theory of penetration was still held by many. It was a number of years before the large hearth was recognized, even though results were being accomplished that spoke for themselves.

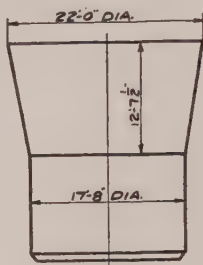
In the exposition of this idea, the Chicago furnaces of

the Corporation, had pioneered, and advanced farther than anyone, and their success was shown in their wonderful yearly record of over 2,000,000 tons, on a coke consumption of well below 1900 pounds, per ton of metal.

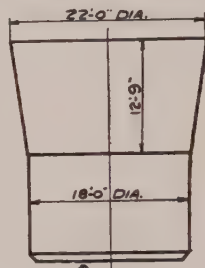
In studying the situation, this development is the only radical one that has been generated in years, which in all



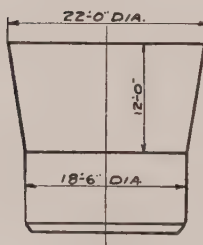
Sketch 51



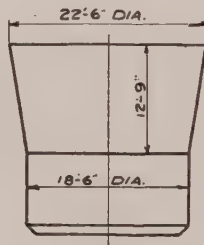
Sketch 52



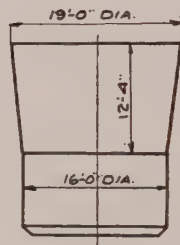
Sketch 53



Sketch 54



Sketch 55



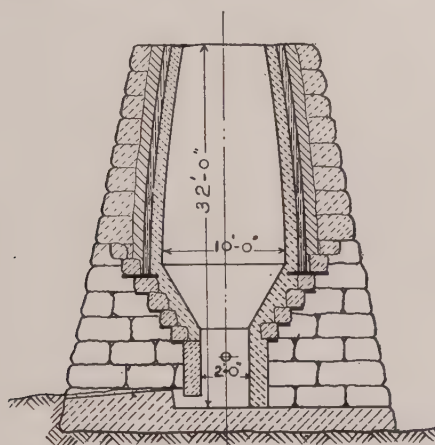
Sketch 56

cases where applied, has shown better productions, increased tonnages, lower fuel consumptions, and in the better use of hot blast temperatures, nearer to those that were used on different materials in the earlier years of American blast furnace practice. It appears to have advanced the progression of new development, using Mesabi ore, and other raw material, inferior in quality to those formerly used, and better results have been gotten in spite of a deterioration of the physical and chemical properties of our fuels.

In furnace plants, where these changes have taken place there have been some remarkable increases of tonnages, etc., in spite of the fact that the materials are the same, or maybe somewhat inferior.

Sketches Nos. 51, 52, 53, 54, 55 and 56, will show some dimensions of present furnaces, boshes, and hearths.

In Table A there are shown a few representative plants taken from different sections of the country, and the results, obtained after changing the hearth. In every case, without exception, there has been a decided improvement for better all around work. This table will also show the various percentages of Mesabi, heats carried, etc.



Slide 1

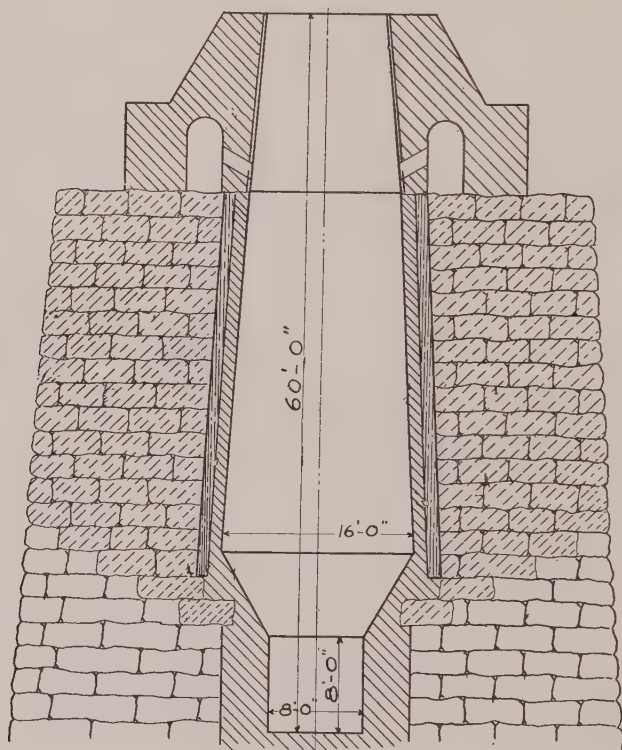
Detail information is lacking from a number of the plants. There has been a similar improvement made in using a wider hearth in smaller merchant furnaces.

In the making of the higher coke irons, such as Ferro Silicon, Ferro Manganese, etc., again has this wider hearth shown a decided improvement on production, smoothness of operation, and in lower fuel consumption. To those who have had the opportunity to watch these ideas there is no doubt that it is the largest step made in recent years to overcome the obstacles of increased ton-nages, lower coke consumption, etc.

In the latter part of 1917, and the first part of 1918, a great many of the furnaces were subjected to the worst possible irregularities (fuel that had lain in the stock pile for years, slack blasts, etc.), yet their performance even

on this inferior material was good, and now, coming out of this irregular period they have gone back to their original good work.

It can be noted in the preceding table that some of the plants on which the furnaces were changed are working on inferior fuel, yet their results compare well with some of the others.

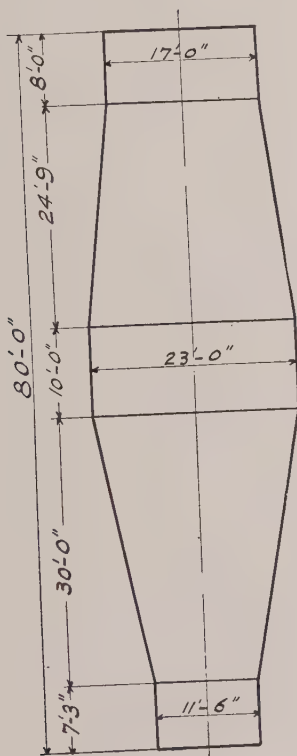


Slide 2

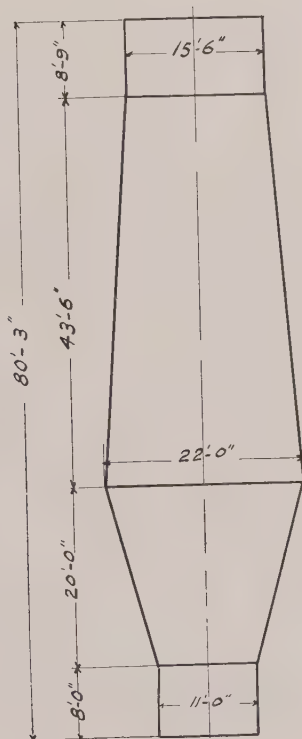
The batter of the upper walls, and the angle of the bosh, are subjects that no longer interest, as much as the relation between the bosh diameter, the hearth diameter, and the distance between these points. The angle of the bosh working out to these dimensions. This angle of the bosh is becoming so nearly vertical that its influence cannot be so serious a matter as it was in former designs.

THE USING OF HIGH BLAST TEMPERATURES.

In the ability to carry higher blast temperatures, the average line of heat at the larger plants, has risen to the 1200°F line, and very often we hear of it being used above 1200°F with a great deal less attending trouble than was experienced in the former years of blast temperature around 850°F.



Slide 3



Slide 4

In using these higher hot blast temperatures on poorer grades of fuel, it is found that close adjustment of the blast volume with relation to the temperature, influences the smoothness of operations to a considerable extent.

For a furnace to use 1200°F of blast temperature, the burden has to be delicately balanced, also in rising from this point to say 1300°F, another adjustment has to be

made. One could not hope to have smooth operations if adjustments are made quickly between such high points. It is a well known fact that a variation of 50° in hot blast temperature, means sometimes good or bad furnace operations, and here the personality of the furnace operators influence somewhat the ability to carry such high temperatures.

The closest attention should be given at all times to the state of the furnace, with the idea of meeting changing conditions.

At places where irregularities do not occur with wide and sudden fluctuations, a close usage of the maximum blast temperatures is possible.

If the plant conditions and furnace operations permit, even with widely varying fuels, blast temperatures can be made to average within 5% of the total available. A large reserve is not necessary with close watching. There are a number of plants that operate for long periods of time, during which the wind variations are the only reserve. The utilization of these relatively high blast temperatures is limited in the majority of cases, even though Mesabi percentages may be above 85%, by the ability to get such temperatures.

This possibility to carry high heats has enabled these plants with lower fixed carbon in their fuel, to obtain very fair results, and also with Mesabi ores being carried beyond percentages that were anticipated only a few years ago. This is shown at Plant "F", in table "A", which made a plant run of 1843-pounds of coke per ton of metal, during the month of March, 1918.

There is some hesitancy, however, in the expression of opinion as to whether the extending of the hearth diameter from 18-ft., to 19-ft. 6-in. or larger, has added anything to the betterment of all conditions.

COMMENT ON THE USE OF INFERIOR MATERIAL.

In the last few years, at those plants where there has been no campaign to improve the coke quality, the general

average of the quality of the fuel has deteriorated. The fixed carbon lowering, ash and sulphur rising.

The large hearth furnaces show good workings under these adverse handicaps. The sulphur elimination shows excellent temperature. Sulphur cannot be controlled unless the hearth temperature conditions are excellent. Averages as high as 1.30% sulphur are being handled daily, on glassy slags, meeting average Mill Basic and Bessemer specifications. This, however, is no attempt to endorse high sulphur in the coke, it is easily figured that anything like this percentage reduces the output to quite an extent.

THEORETICAL LINES.

The ultimate blast furnace of 600, 650, and 700-tons daily average over a period of a lining's life is just as much a conjuncture as has been the development of the 550-ton furnace.

We find early English furnaces that were built with 43,000 cubic feet capacity, and their results showed no conclusion.

There is no reason to think that the bosh or the hearth diameter has been carried too far. The percentage of influence that might be gotten by retarding the stock descent with an angle of approximately 83° , is small in comparison with the total cubic contents of the bosh.

The high points of production gotten lately at different plants (for instance the Monnessen Furnace, of the Pittsburgh Steel Company), are a source of very interesting study to the fraternity at large.

This plant has consistently produced very high tonnages over a period of years, and it would be for the good of the fraternity in general if we could hear of something from this practice.

In other places where the fuel has been given close attention, we find large outputs being attained on short runs. As a rule they have not been maintained for long

periods, and these runs are at places that have produced a very high quality of fuel. One is inclined to believe the increase of production, etc., is to be advanced by a bettering of the fuel and other material.

The regulation of the blast furnace, for the amount of material used, is as close as any human machine, and as a rule the material given to the furnace operators is one that varies widely.

The physical properties of the fuel is one that influences consistent furnace development, owing to the fact that between the lining, there may be a varying condition which upsets all study or calculation. If the fuel is soft, small and irregular, all efficiencies at hand cannot be used to the best advantages.

In obtaining some of the results of the last four or five years in coke practice and tonnages, there are plants which have worked continually under conditions of regulation, whereby for long periods at a time, it would have been a difficult matter to have increased the burden more than one or two per cent, and this on using material that in former years was condemned very severely.

The one thousand ton furnace is not an idea that will be abandoned but will be attained, whether along the present lines, or a complete revolution of designs, no one knows. Science has not been able to go any faster than practice has allowed.

There is no doubt that the temperatures within the furnace are sufficient to do all the work of reduction, etc. The time element necessary for reduction is stationary within certain limits. Where this time element is hastened through unusual, unpremeditated, and uncontrollable conditions we find abnormal productions, efficiencies, etc., for short runs.

If, as in other lines of science, progression is by spurts rather than by steady increase, then these points of high production, lower coke practice, etc., will come gradually closer together, and the average lines of results desired will be gradually raised.

Modern progression of metallurgy has been paralleled by better adaptations of the mechanical construction. Without the perfect mechanical construction a steady increased production would have been retarded. The simplest of details have been worked out where the lost time of the furnace operation has been reduced to a small figure.

In the operation of any design, etc., at a blast furnace plant, the personality of the operatives is one that reflects largely on the results attained, and these should be of the best type possible, owing to the fact that nowhere do we find so large a responsibility placed on as small a crew, as we do around a modern blast furnace.

In presenting any paper or pamphlet to this institution, acknowledgment of indebtedness should be made to the United States Steel Corporation, by the blast furnace men of America. The fraternity at large is obligated to it for the remarkable lead in construction, freedom of discussion, and distribution of main ideas, etc., that has always characterized its spirit of co-operation. We find in the case of blast furnace development that it has freely distributed to the country at large, any design, or idea that may have cost large sums to develop. One can safely say that practically all the lead in any field of blast furnace work has been assumed by it, and freely has it given to its competitors its own ideas and plans.

PRESIDENT GARY: Discussion by Mr. Collord of the Shenango Furnace Company.

THE PRINCIPAL CHANGES IN BLAST FURNACE LINES DURING THE LAST TEN YEARS.

Discussion by GEORGE L. COLLORD,

Vice-President, The Shenango Furnace Company, Pittsburgh, Pa.

It is difficult to add anything to Mr. West's most instructive and valuable paper, but I want to say a few words to illustrate the better blast furnace *practice* brought about largely by the change of *lines* in the hearth and bosh sections.

When our furnaces were lined up with small hearths (12' to 14') and a flat bosh (72° to 75° angle), we could run along fairly regularly and make a uniform grade of iron, provided there were no irregularities in the raw materials or interruptions in operations.

When anything interfered, such as a long shut-down of twelve hours or more, a different grade of coke or ore, or a change of atmospheric conditions, it would generally bring about an irregularly working furnace, resulting in lower tonnage, an off grade of iron, increase in coke consumption and production of flue dust.

Especially was this the case when it was necessary to change a furnace from one grade of iron to another. It would take from two to ten days often to change from a high to low silicon iron with attendant irregularities mentioned above.

These changes have been very much simplified with a furnace lined up as Mr. West has described. I want to give one particular instance to illustrate this point. In 1914, when there was not much demand for iron, it was necessary to take orders for almost any grade of iron that was offered. We had only one furnace in at this time, but fortunately it had been recently put in on the modern lines with 16' hearth and 79° bosh angle. This furnace ran for months, making Bessemer

iron with 2-2.50% silicon for six days in the week, and low silicon iron (below 1%) on Sunday. On one occasion it was necessary to fill an order for 500 tons iron running 4% silicon. By lightening the ore burden, increasing the acid elements in the slag, and carrying all the stow heats possible, this furnace changed from a 1% silicon iron to 5% in twelve hours and back to 2% silicon iron in another twenty-four hours without a miss-move of any kind. The output for this period was maintained above 500 tons per day, and coke consumption below 2000 lbs. I think I am safe in saying this would be impossible with the old line up.

A number of furnacemen making high silicon iron, hesitate to put in the steep boshes. This is a mistake, as we have one furnace running nearly four years, with 78° bosh angle, and another one three years with 79° angle and believe average silicon in iron produced on each would run 2.25%.

Flue dust loss on one furnace has been as low as 77 lbs. per ton of pig for a year. This compares with 388 lbs. on a former blast.

Another point I want to mention. This is the physical quality of iron produced on a large hearth furnace, compared with the small. A large per centage of our iron goes into ingot moulds. They require an iron that will expand and contract readily with the frequent filling of molten steel—this requires a soft iron. It has been proven from experience that iron produced on a *small* hearth furnace can have the same silicon, sulphur, phosphorus and manganese content as iron produced on a *large* hearth furnace, but it is harder and generally closer grained and does not withstand expansion and contraction like the other iron. We find the graphic carbon about $\frac{1}{2}\%$ higher in iron made on larger hearth furnace—this indicates much softer iron.

During the past severe winter, it was necessary to bank furnaces for weeks at a time, due to coke shortage. Again the furnaces constructed on the new lines showed

their superiority over the old ones. We shut furnaces down, expecting the start up within forty-eight hours and would give the furnaces a small quantity of coke extra. Instead of being down two days, we would have the blast of two weeks and more. On starting up, we would have one cast of iron dull in appearance and sluggish in running, but the second cast is generally good physically and chemically. In other words, the modern furnace can stand more abuse than the old.

We furnacemen connected with companies outside of the United States Steel Corporation and other large operators are much indebted to them for the complete data they so willingly and cheerfully give us.

PRESIDENT GARY: Further discussion by Mr. Frazer of the Pittsburgh Steel Company.

THE PRINCIPAL CHANGES IN BLAST FURNACE LINES DURING THE LAST TEN YEARS.

Discussion by J. STANFORD FRASER,

Superintendent, Pittsburgh Steel Company, Pittsburgh, Pa.

The time available since getting a copy of Mr. West's paper on Tuesday evening from Mr. Meissner of New York, has been very limited to study the contents of a paper of this size and on this subject.

During the last few years I have read many of the books on blast furnace design and routine of operation. I have also read, with a great deal of benefit and interest, the many excellent papers presented before members of the Institute, and as I glanced through Mr. West's paper hurriedly, the thought occurred to me, this paper has required a lot of time and work, is excellent in its arrangement, and covers, in short, the ground that modern blast furnace practice and design now demand.

As I read the paper more carefully, I was more and more impressed with its thoroughness and its usefulness to men handling blast furnaces at this time, when conditions that were practically under control a year or two ago do no longer exist, due more or less to the irregularities of materials to be used, labor shortages and other causes. Mr. West is to be congratulated on this most commendable paper which has covered the ground so thoroughly that little remains to be said, except to concur and to discuss a few of the many interesting points brought out. In this case I shall only quote from certain paragraphs of his paper the items that interested me most, and in a brief way give, as requested, a short outline of the work done at Monessen Furnaces.

Items 1-2-3 and 4 point out the way to maximum production. Item 1. A thorough knowledge beforehand of material suitable, both physically and chemically, and

with regularity, covers the subject of materials for a blast furnace. One point might be added, that these materials have somewhat of a preliminary cleaning before charging, i. e., the elimination of excessive sulphur in some grades of coke by coal washing where the coal is suitable for this kind of treatment; the elimination of coke braize, where the amount is excessive, and the removal of as much of the deleterious matter in stone as possible, when necessary.

Items 2 and 4. Apparatus of proper design that permits of continuous running, as time lost cannot be reclaimed, and the effect of frequent stops is injurious.

Item 3. An attentive, ambitious, and skilled organization in their particular line, keyed up, as Mr. West expresses it, to the point where time means everything and carelessness spells failure.

In furnace design much has been accomplished in recent years to get proper heights for blowing large volumes of blast, correct bosh angles, and hearth dimensions, and as expressed by Mr. West, the credit must go where it largely belongs, to the South Chicago Works of the U. S. S. Corporation for the development of steeper boshes to meet the conditions of faster driving, associated with the ever increasing fineness of ores, so that now the designing and operating of blast furnaces is almost to a point of following sane, methodical and established standards.

Much has been said and written about the different designs of furnaces, methods of cooling, methods of charging, methods of maintaining the lines of new linings, bosh angles, hearth reinforcement, and protection, and I believe all furnace men agree that a uniformly cylindrical throat at stock line must be maintained for good distribution, so essential to the efficient and smooth working of furnaces, correct angles on bell design to give correct filling.

On the subject of stock line protection, I like the methods as illustrated in Sketches 4 and 5. The latter

has worked very successfully at the Monessen Furnaces, and one similar to that shown in Sketch 4 at several other furnaces with which I am familiar.

For lining protection above mantles, Sketch No. 21 shows one that has worked well, keeping plates back to assume lines of distortion. On bosh construction the copper plate design set in brick work, care being taken to not over-cool by having too much copper, is practically the standard used on soft ore practice. Design as shown in Sketches 29, 30 and 33 are considered good. The tuyere section, as illustrated in Sketches 36, 37, and 38, would also be considered good design, and water-cooled cast iron hearth jackets made up of segments, heavily banded on the outside, as shown in Sketches 41, 42 and 44, work very satisfactorily.

The above are almost the established standards of design at the Monessen Plant. This plant has two furnaces, alike in every detail of design and construction and of following dimensions: Hearth Dia. 16'-0"; Bosh 22'-6"; Stock Line 16'-0"; Height over all 91'-0"; Bosh height 14'-2"; Bosh Angle $77\frac{1}{2}^{\circ}$.

The first furnace completed, was blown in Aug. 5th, 1913, smelting 1,915,653 tons of ore and miscellaneous materials, making 1,000,000 tons of pig iron of very uniform analysis in 4 years, 9 months and 28 days, on an average coke practice throughout the campaign of 2192 lbs., and still running on an average of 492 tons per day, and shown no external indication of trouble. For the years 1914, 1915 and 1916, the total production on this furnace was 663,949 tons.

Due to business conditions, the second furnace did not run as steadily and was on many grades of coke. It has been in blast 3 years, 1 month and 18 days and has made 621,949 tons of pig iron to date on a coke practice of 2179 lbs. During a steady run of the two and half years, beginning July 1st, 1915, this furnace produced 541,914 tons. This coke practice on both furnaces includes 3.7% of fines, screened out and used elsewhere.

The work and behavior on both furnaces have been very satisfactory, and the credit for the work must be placed where it belongs, beginning first with the owners, the engineers, and men whose efforts have been applied to the building of a well designed and balanced plant, as one of the requirements mentioned in Items 2 and 4 of Mr. West's paper; secondly, to the nearest available classification of ores, the character of which corresponds and yields to smelting in the same temperature zone; thirdly, to the quality, uniformity, and cleanliness of the coke used, although not of carbon content exceeding 88%, and to an organization who have applied all their efforts and knowledge in keeping the furnaces in harmonious action, and as nearly perfect equilibrium as possible, as applied to all the external operating conditions, and as also applied to the steady descending columns of solid materials meeting the ever ascending columns of gases, associated with the varying temperature conditions so necessary to uniform work.

PRESIDENT GARY: Further discussion by Mr. Mathesius of the Illinois Steel Company.

THE PRINCIPAL CHANGES IN BLAST FURNACE LINES DURING THE LAST TEN YEARS.

Discussion by WALTHER MATHESIUS,

Superintendent of Blast Furnaces, Illinois Steel Company, South Chicago, Ill.

In the introductory part of his paper Mr. West has enumerated as the four most prominent prerequisites to good blast furnace operation:

1. Uniformity of raw materials.
2. Suitable design of apparatus.
3. Efficient management and operation.
4. Perfection of mechanical equipment.

Without detracting in the least from the importance of any other of these features, I desire to emphasize the necessity of correct design, especially of the furnace proper. The furnace stack practically being inaccessible for the entire duration of a campaign, it is impossible to correct faulty design of the same or any part thereof until after the campaign has come to an end. Since it is a well known fact that deficiencies in this respect cannot be overcome even by the best of furnace practice, the far reaching influence of the furnace design on the results accomplished during a campaign which as a rule extends a number of years can be readily conceived.

I should not be expected to discuss Mr. West's paper from the standpoint of a critic. A certain similarity in our line of reasoning would only be natural since we both had the opportunity to observe together at the South Works of the Illinois Steel Company a good part of the recent development in blast furnace construction, which Mr. West has described as having been wrought during the years of 1910 to 1917. I hope, however, to be able to illustrate a little further some of the points brought out by Mr. West.

STOCK LINE PROTECTION

Following in general his division of the subject into sections of furnace height, I wish to first mention briefly some of our experiences at South Works with different types of wearing plates.

Early attempts at stock line protection, made by using large cast iron segments held against the face of the brick work by anchor bolts fastened to the shell were not encouraging. The life of these plates was found to be rather short, since the cast iron, under the influence of the furnace gases, would absorb carbon, which caused swelling and disintegration. This attempt was followed by the installation of segmental steel plates similar in design to the former. These plates gave good service as long as the top temperatures remained uniformly low. However, when used under conditions where higher top heats could not be avoided, the steel plates warped badly, some of them became unfastened, and a considerable disarrangement of the brick work at the stock line was the result.

NO. 3 BLAST FURNACE
Bessemer Iron

Year 1913 Month	Aver. Daily Tonnage	Coke per Ton of Iron	Coke Used	Tons Made on Lining
				533,800
Jan.	469.1	2408	Gary By-	
Feb.	477.3	2317	Product	
Mar.	490.0	2237	"	
Apr.	495.9	2257	"	
May	490.7	2179	"	
June	411.1	2209	"	639,823
Furnace Banked June 26th.				
Resumed Operation July 2nd.				
July	407.5	2365	Gary By-	
Aug.	495.9	2006	Product	
Sept.	522.5	1890	"	
Oct.	514.0	1964	"	
Nov.	528.0	1937	"	
Dec.	500.3	1932	"	
				730,313

Inferior furnace practice bore ample proof to the fact that no stock line protection whatever was superior to

protective devices which would not retain their original shape, and were not absolutely secured in their position. I should like to illustrate this point by presenting a few figures concerning the performance of one of the South Chicago furnaces during the year 1913.

This furnace was equipped at the stock line with cast steel wearing plates of the type mentioned, and as shown performed rather poorly during the fore-part of the year. On June 26th, the large bell became detached from the bell rod on account of a defective casting. During the ensuing repairs what was left of the stock line protection was removed, and the brick lining of the throat was repaired, thereby re-establishing the original stock line dimensions. Outside of these stock line repairs, no changes were made so that the remarkable improvement of practice as experienced during the following months, is clearly and exclusively attributable to the rebuilding of the stock line.

As the result of our experiences with wearing plates made of steel as well as of gray cast iron, we abandoned the use of both of these materials, and since the year 1912 have installed segmental wearing plates imbedded in the brick work and made of a low silicon, high sulphur cast iron. This material containing a rather large part of its total carbon in the combined form, is on account of its hardness, well suited to resist abrasion, and at the same time is not subject to disintegration under the influence of the furnace gases. The results obtained with this type of stock line protection have been most gratifying in every respect.

THICKNESS OF LINING

Referring to Mr. West's report on the changes of opinion and practice regarding the thickness of lining to be installed in the inwall section of the furnace, a few notes on the recent performance of the thin lined, water-cooled furnaces at South Chicago may be of interest. One should bear in mind that these linings were originally installed in competition with such of 50 to 60 inches in thickness;

also that while the latter were built with a large amount of experience on hand, the early furnace campaigns on thin linings had to suffer for many mistakes in detail of design. This was especially true concerning the chief difficulty experienced in the beginning, that of water leakage, which brought a number of furnace campaigns on thin linings to a premature end. It can be safely said that trouble of this nature has been definitely overcome, and recent performances of thin linings have fully proved their superiority over the old 60 inch inwall. For example, No. 8 furnace at South Chicago during its present campaign had produced on a 13½ inch lining up to May 1st of this year a total of 559,173 tons at the rate of 544.4 tons daily and with a coke consumption of 1901 pounds per ton. This record compares very favorably with that of the other furnaces of the South Chicago group for the same period of time. The same may be said of No. 5 furnace at South Chicago, which to May 1st of this year produced on a 13½ inch lining 323,260 tons and is expected to more than equal the record as established now by our No. 8 furnace.

From the performance of these furnaces the conclusion must be drawn that wherever it is deemed advisable to resort to water cooling above the mantle it is by far to be preferred to apply this water uniformly to the outside of the furnace shell in connection with a comparatively thin lining, rather than to install water cooled boxes or plates inside of the lining and shell, where they are inaccessible, liable to cause trouble through leakage which cannot be readily discovered, and yet unable to exert a cooling effect of the required uniformity so as not to cause irregular wearing of the brick lining.

However, modern American practice on high blast heats has well established the fact that at least on standard grades of iron water cooling above the mantle is not required. The zone of the highest temperature being confined to its proper dimension, that is to the bosh immediately above the tuyere level, no undue wear of the

brick work above the mantle takes place. This development has in my opinion deprived the old type of heavy lining of all justification, and I believe that in future a large majority of furnaces will be built with linings just heavy enough so as not to require water cooling. A lining of this type will offer sufficient resistance to abrasion and wear to insure a satisfactory length of campaign. It will at the same time permit an enlargement of and deviations from the original profile which toward the end of a campaign will result in a deterioration of furnace practice and economy as to demand a relining for economical reasons rather than on account of the wearing away of the lining. The relining cost of such a furnace will compare favorably with that of its thin lined competitor; it will not be dependent as closely as the latter upon the exact shape of the shell and will be free from the complication of water cooling and its expense.

LARGER HEARTHES AND STEEPER BOSHES

Referring to Mr. West's remarks concerning the enlargement of the hearth as inaugurated at the South Chicago furnaces, I desire to emphasize that this development was undertaken not in order to enlarge the furnace and thereby increase its productive capacity, but for the purpose of steepening and lowering the bosh with the object of reducing the impeding action offered by the bosh to the uniform descent of the stock, and thus achieving a greater uniformity in the working of the furnace with ensuing better quality of product and improved furnace efficiency.

To what extent these expectations were realized, may be judged from the performance of the South Chicago furnaces during the past three years, and it can safely be stated that the increased production gained at these furnaces during this period, was solely the result of smoother furnace operation. Mr. West has mentioned that larger hearths and steeper boshes have enabled operators to maintain reasonable furnace practice even under

most adverse conditions of raw materials and operation. We have had the opportunity to fully realize this at the South Chicago furnaces during the past year. I am convinced that it is only through the correct development of our furnace lines, the large hearth dimensions and steep boshes, that we have been able to operate our furnaces during the past eighteen months of most extraordinary irregularities, with continuous coke changes and frequent banking, without getting into serious trouble and without grave and permanent damage to furnace linings and equipment.

These conditions have not as yet permitted the full realization of the advantages in furnace practice which we expect from the most recent development of furnace lines at South Works and which has led to a still further increase of the size of the hearth. Having practically eliminated the bosh as a restricting influence to the stock movement the next logical step was to increase the batter of the inwall to ease the descent of the charges. With a given stock line dimension this required an increase of the bosh diameter and in turn, maintaining the proven angle and height of bosh, brought about a further increase of the hearth so that the 20 ft. line of the hearth diameter has finally been crossed.

PRESIDENT GARY: Any further discussion? We all appreciate very highly the time and talent devoted to the papers read at these meetings by those who prepare them. We will now take a recess until 2 o'clock. In the afternoon the first paper will be by Mr. T. W. Robinson, Vice-President of the Illinois Steel Company. Let us re-assemble promptly at 2 o'clock to hear Mr. Robinson.

THE TRIPLEX PROCESS OF PRODUCING ELECTRIC STEEL AT SOUTH CHICAGO

THEODORE W. ROBINSON,

Vice-President, Illinois Steel Company, Chicago, Ill.

It is a far cry from Benjamin Franklin expounding American democracy in the court of France to the maintenance of American ideals on the battlefields of Europe, yet the enlightening power of Franklin's statesmanship promises to pale into insignificance before the compelling force of the guns that are being produced through his genius in electrical discovery. Electric steel has played no unimportant part in the paths of peace. It is about to play a more important part in the theater of war.

This paper has to do with the triplex process of producing electric steel as carried out at the South Chicago works of the Illinois Steel Company. In the following survey it has been the aim to leave the description of physical features of plant largely to illustrations and drawings, and to confine process reference to its most salient points. The technicalities of general plant design and operation of the electric furnace have been ably presented before this institute by Mr. W. R. Walker, Dr. John A. Mathews, and others. The object of this paper will have been achieved if, with a minimum of repetition, it supplements existing records with later developments, especially in connection with the manufacture of electric steel in relatively large quantities.

THE DEVELOPMENT OF ELECTRIC STEEL AT SOUTH CHICAGO.

The development of electric steel at South Chicago was based upon the fundamental conception that the electric furnace was pre-eminently adapted to the manufacture of carbon and alloy steel of the highest quality; that it would be possible to produce electric steel in sufficiently large units to permit its use in heavy prod-

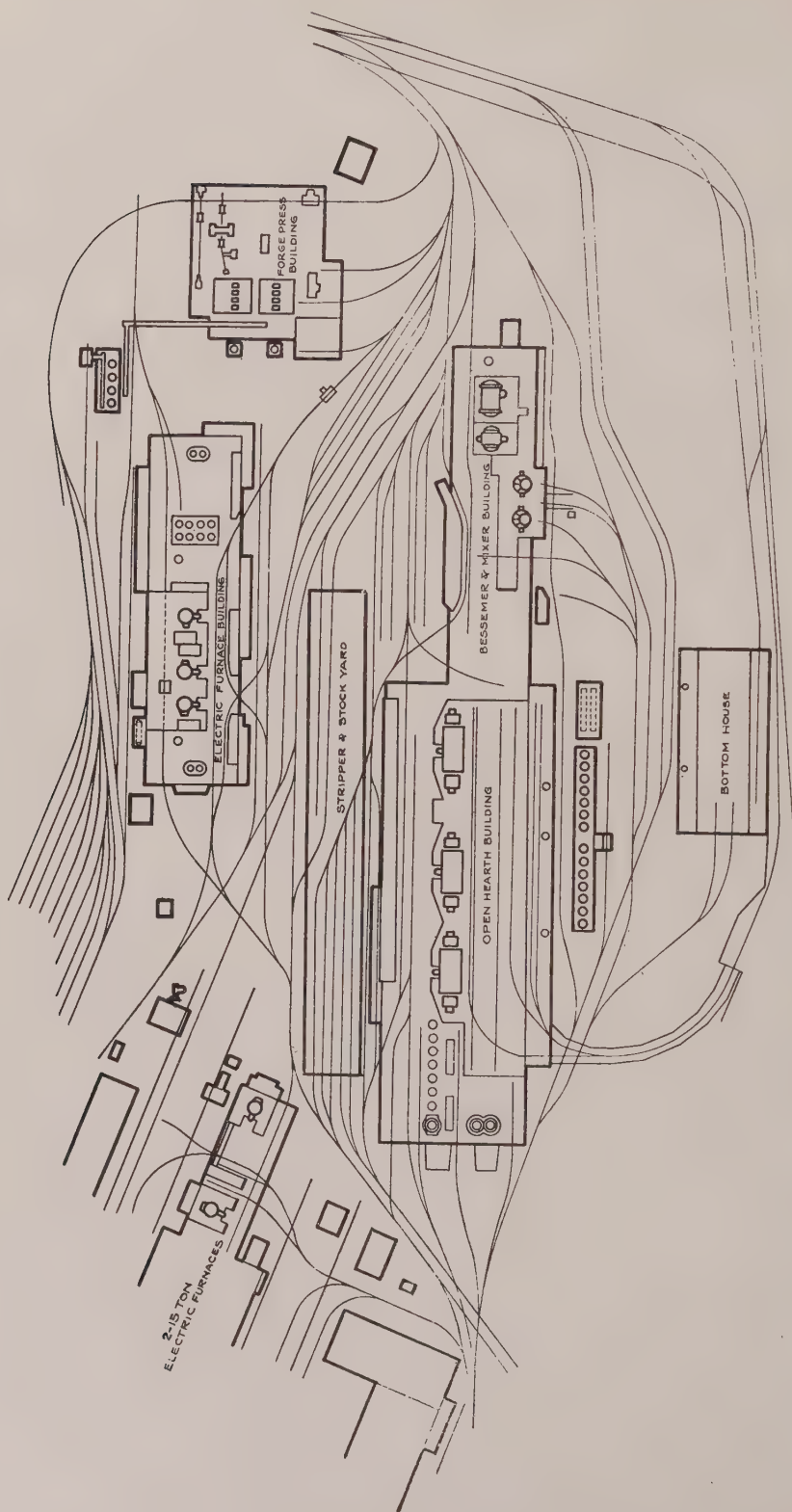
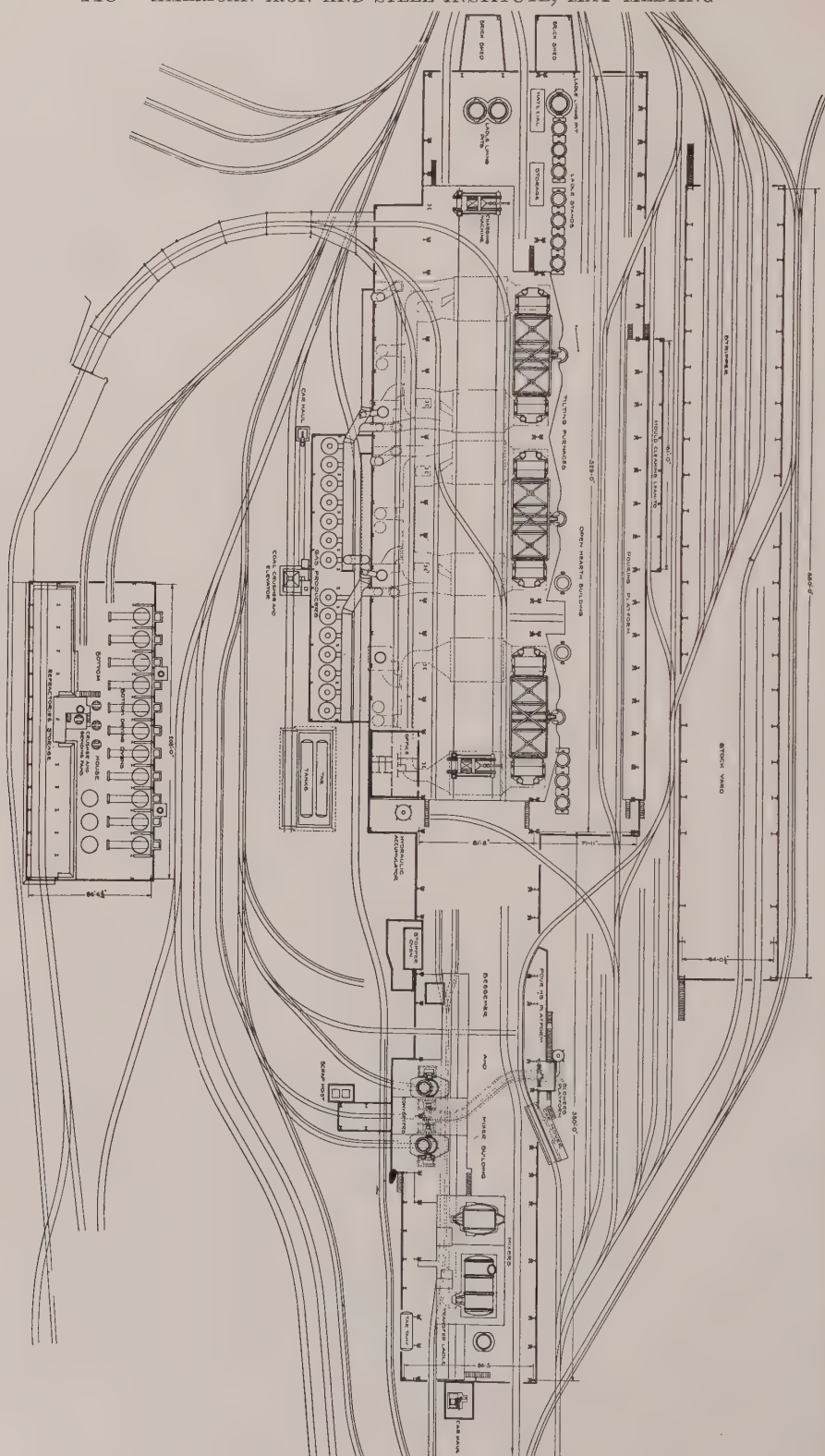


Fig. 1. Duplex and Electric Furnace Plants

ucts; and that the increasing demand for high-grade steel would provide a sufficiently extensive market to make its manufacture commercially possible.

Under these premises, the Illinois Steel Company in May, 1909, installed its first electric steel furnace at the South Chicago works. At that time there were only two other electric furnaces in this country concerned with the manufacture of electric steel—one at the Halcomb Steel Company, Syracuse, New York, and the other at the Firth Sterling Steel Company, McKeesport, Pennsylvania. The furnaces here and abroad were all small, running from a ton or less to five tons in capacity. Our installation consisted of a fifteen-ton basic-lined Heroult furnace with an electric equipment for three-phase, twenty-five cycle and one hundred and ten-volt current. The manufacture of electric steel was a new art, and ours was a new adaptation of a new art. As to the troubles we encountered, I may say their name was legion. Perseverance conquered, however, and we soon had the satisfaction of producing a metal of unquestionably superior quality.

As the fundamental object was to demonstrate the opportunities of the new process in connection with heavy products, attention was early turned to the experimental manufacture of electric steel rails. Under the limitation of equipment it was necessary to depart from standard rail practice to the extent of accumulating cold ingots and reheating them. The electric steel used was made from Bessemer blown metal. We advisedly felt our way in chemistry. Irregularities incident to incomplete equipment were unavoidable. In spite of pioneering difficulties, about 10,500 tons of electric steel rail were laid on fourteen railroads throughout the country. The result of these rails in track indicated that electric and open-hearth rails of like chemical composition had practically the same resistance to wear when the former were made under the conditions that existed at the time of their manufacture. The failure from breakage was almost negligible; there were no interior defects;



and the test showed that the electric steel was considerably more ductile at low temperature than either the open-hearth or the Bessemer steel.

TESTS WITH STEEL RAILS AND THEIR RESULTS.

In order to further determine the facts, a series of experiments was undertaken with a view of testing the ductility of rail steel at low temperature. A refrigerating plant was erected adjacent to our regular drop-testing machine. About nine hundred pieces of electric, open-hearth and Bessemer rails of various sections were tested at temperatures ranging from seventy degrees Fahrenheit to fifty degrees below zero. These tests emphasized that in the case of all the steel there was a marked decrease in resistance to shock as the temperature lowered. Relatively speaking, however, the electric steel was distinctly more ductile than either the Bessemer or open-hearth. The following summary from two electric and two open-hearth heats of similar analysis involving 242 tests is typical of the general results obtained. The figures given in Tables B, C and D are average results. The chemical composition of the heats in question is as follows:

TABLE A

	Car.	Mang.	Phos.	Sul.	Sil.
First electric heat	.64	.60	.024	.019	.216
First open-hearth heat	.62	.71	.020	.040	.140
Second electric heat	.73	.90	.022	.043	.256
Second open-hearth heat	.72	.88	.035	.033	.200

TABLE B—Average Number of Blows Required to Break the Rails

Temperature	Electric	Open-Hearth	Comparison
*+60° F.	3.48	3.50	O.H. 0.6% over Elect.
0° F.	4.41	3.82	Elect. 15% over O.H.
—30° F.	4.55	2.24	Elect. 103% over O.H.
—40° F.	3.31	2.03	Elect. 65% over O.H.

TABLE C—Deflection Before Breaking Blow

Temperature	Electric	Open-Hearth	Comparison
*+60° F.	2.96"	3.36"	O.H. 14% over Elect.
0° F.	1.41"	1.23"	Elect. 15% over O.H.
—30° F.	1.46"	0.58"	Elect. 152% over O.H.
—40° F.	0.91"	0.43"	Elect. 112% over O.H.

TABLE D—Elongation in Twelve Inches Measured After Last Blow Before the Destruction

Temperature	Electric	Open-Hearth	Comparison
*+60° F.	0.808"	0.929"	O.H. 15% over Elect.
0° F.	0.404"	0.397"	Elect. 2% over O.H.
30° F.	0.420"	0.201"	Elect. 109% over O.H.
40° F.	0.297"	0.141"	Elect. 111% over O.H.
*60° F., 18 ft. drop. 0° F. and below, 8 ft. drop.			

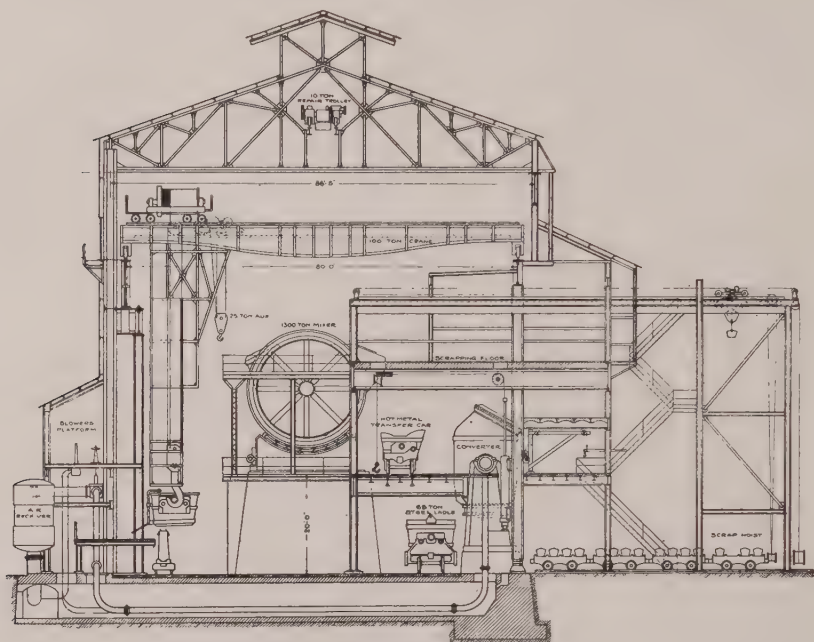


FIG. 3. Section of Bessemer and Mixer Building

In all these tests the height of drop was kept comparative. At normal temperatures eighteen feet was employed. At zero Fahrenheit and below, the steel, weakened by the cold, could not withstand so heavy a blow, and the drop was reduced to eight feet. While it is self-evident that the number of heats involved in the above tables is entirely too small to permit the drawing of definite conclusions, the fact that the other drop-tests and the result of the rails in track all pointed in the same direction warrants the belief that the resistance to dynamic force rapidly decreases with lower temperature in the case of both open-hearth and electric steel, and that electric steel is tougher than open-hearth steel at low temperatures.

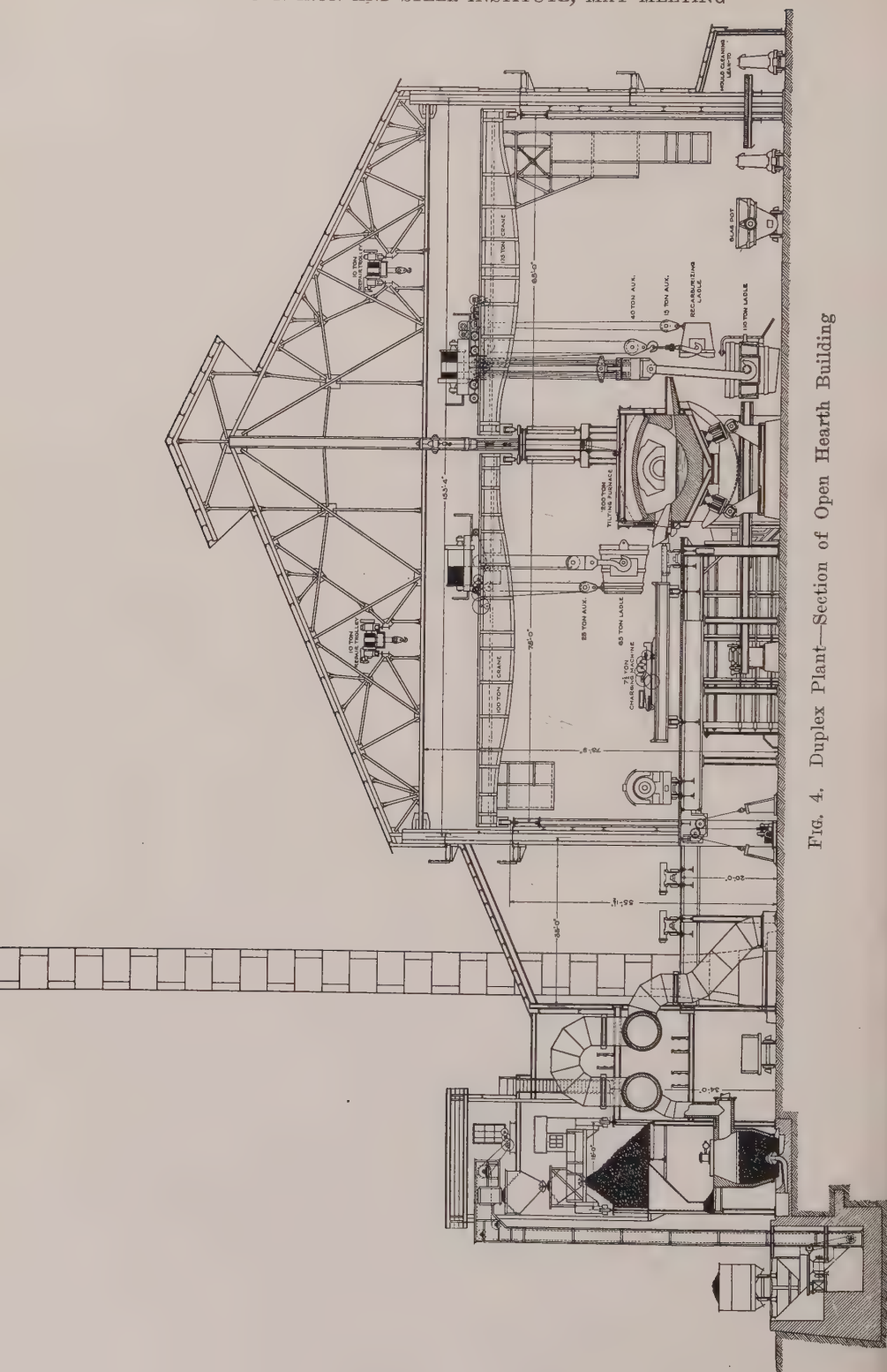
During and after the period in which we were manufacturing electric steel rails, we were experimenting with such other heavy products as forgings, plates, axles and structural shapes. Not only had carbon steel been made

in relatively large quantities in connection with these productions, but the field of alloy steel had been comprehensively entered. Expanding demand led to the introduction in July, 1916, of a second furnace similar to the original one in electrical equipment and capacity. This gave a combined capacity of about 4,500 tons of electric steel ingots per month.

THE NEED OF THE DUPLEX PROCESS.

By this time our experience had verified in a large measure the soundness of the views upon which our original electric furnace installation was predicated. We had demonstrated that it was possible to produce electric steel in relatively large units without the sacrifice of quality. The physical characteristics of the steel had proved to be admirably adapted for heavy products. There was a growing demand for a superior steel for general purposes, and the call for alloy steels was rapidly increasing in connection with the automobile and other industries. Extent of market was largely a question of price, and price logically was largely a matter of cost.

In the meantime an addition to our open hearth at South Works had become desirable, and in connection therewith the matter of increasing our electric steel capacity was taken under consideration. In studying this subject, we were naturally guided by our past experience. We had made electric steel by the melting of cold stock. We had refined in the electric furnace both molten-blown Bessemer metal and molten open-hearth metal. We also had made steel by the initial refining of Bessemer blown metal in the open hearth, supplemented by final refining in the electric furnace. Part of this work was experimental in character. None of it was done under ideal economic conditions. The cost of producing steel in the electric furnace was vitally influenced, of course, by the amount of power used, and this and other conversion items were in turn largely influenced by the tonnage produced. Manifestly nothing could be consid-



ered that would sacrifice quality for output without destroying the very essence and reason for the electric process.

As electricity is an expensive metallurgical fuel, the melting of cold stock or the preliminary refining of metal in the electric furnace could be accomplished only at the expense of a comparatively high fuel cost. Our original practice was to make electric steel by refining Bessemer blown metal. This process necessitated two distinct operations in the electric furnace, namely, dephosphorization by the use of an oxidizing slag, and deoxidization by means of a reducing slag. Steel of the highest quality can be produced by this practice, but there is obviously greater liability to irregularity in this method than when open-hearth metal is used from which the phosphorus previously has been eliminated. It is well to remember that the electric furnace, while a highly efficient instrument, is far from fool-proof. Several years' experience with the use of Bessemer blown metal in the stationary open-hearth furnaces under the local conditions that existed had helped to demonstrate the advantages of the duplex process for producing open-hearth steel. It likewise had been shown that electric steel could be most advantageously produced at South Chicago by the use of open-hearth metal.

It was essential that the proposed plant should be so designed as to provide not only Bessemer metal for open-hearth refining and open-hearth metal for electric refining, but Bessemer ingots and open-hearth ingots as well. Many new problems were involved. It was clear that for the simultaneous production of Bessemer, open-hearth and electric steel, extreme elasticity of operation was fundamental if efficiency was to be attained. Close assembly of the various units was essential for rapid and economical practice. The sequence of operation had to be unobstructed. A supply of hot pig metal and preliminarily refined molten steel must be provided. The plant as finally designed, both in respect to its general plant

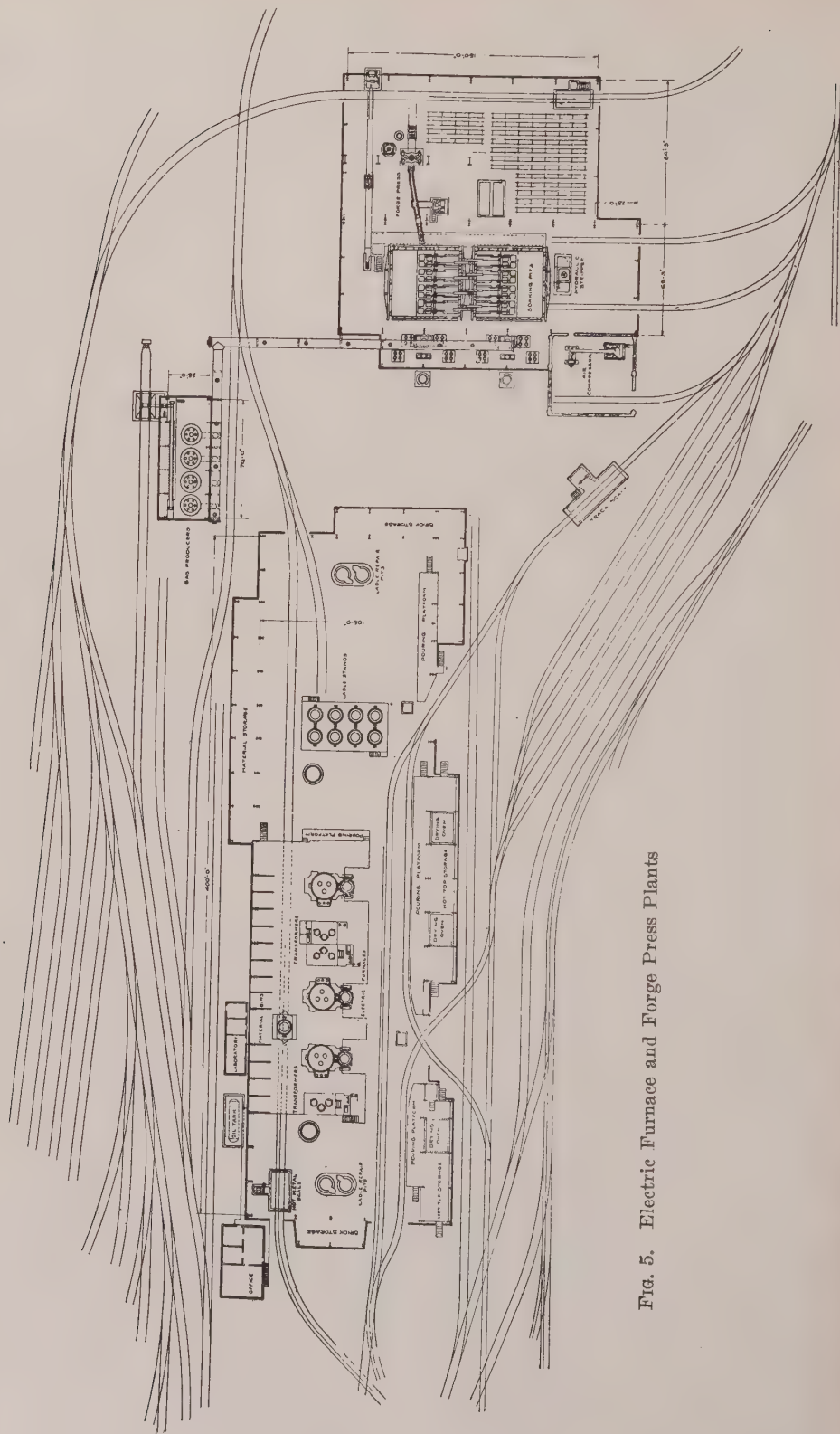


Fig. 5. Electric Furnace and Forge Press Plants

location and its general details of construction, is shown on Drawings Nos. 1 to 7, inclusive.

THE OPERATIONS OF THE DUPLEX PLANT.

Inasmuch as this paper deals specifically with electric steel, no attempt will be made to give a detailed description of the Bessemer and open-hearth refining as carried out in the new plant at South Chicago. The metallurgy and physical manipulation present little that is novel, and the principles of the duplex process as such are well understood.

In respect to the plant, it will be noted that there are two main buildings, one comprising the duplex plant proper, and the other, parallel thereto, containing the electric furnaces. As an adjunct to the latter, there was installed a 1,500-ton forge press. In its essential features the duplex plant consists of two mixers, one of 1,300 tons and one of 300 tons capacity; two 25-ton acid-lined converters and three 250-ton tilting open-hearth furnaces. The mixers are commanded by two cranes, one of 100 tons and one of 75 tons capacity, and the mixer metal is transferred on an elevated platform to the converters by a 25-ton transfer ladle operated by cable and winch mechanism.

When used in the open-hearth furnaces, two heats of Bessemer blown metal are poured into a 65-ton ladle commanded by a narrow-gauge locomotive. Elimination of slag is accomplished by nozzle pouring into a second ladle. When Bessemer ingots are to be produced the metal from one vessel is poured into a smaller ladle and transferred to the Bessemer pouring platform. The three tilting open-hearth furnaces, each of which has a hearth area of 892 square feet, are electrically operated, and are so constructed as to be heated either with producer gas or with tar. Air chambers having a volume sufficient for 10,472 cubic feet of checker work, and gas chambers having a volume sufficient for 6,734 cubic feet of checker work provide liberal regenerative capacity. Two low-

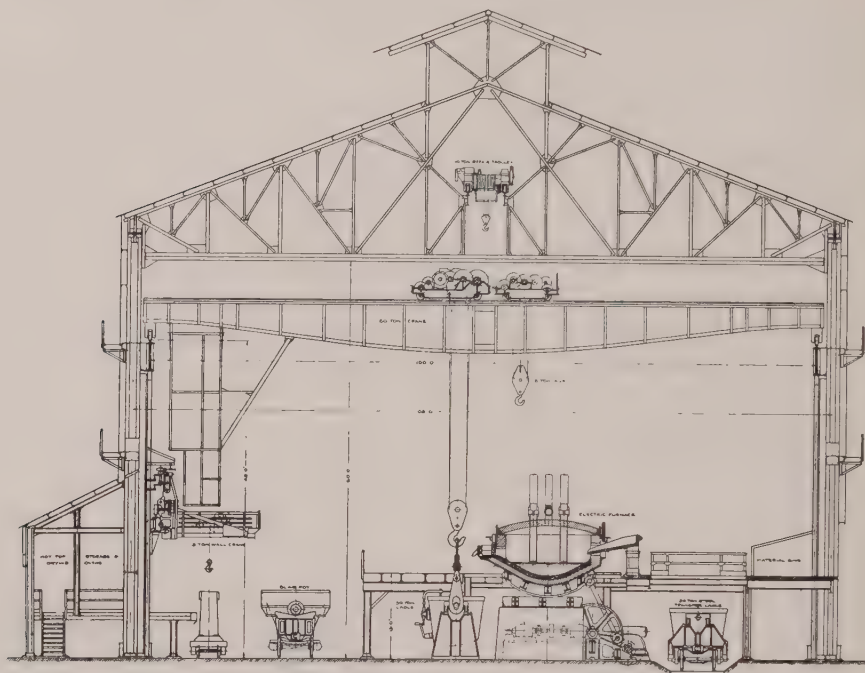


FIG. 6. Section of Electric Furnace Building

type seven-and-one-half-ton charging machines and four one-hundred-ton overhead cranes assure the rapid handling of material. The pit side of the open-hearth department, which is generous in its dimensions, is served by two 175-ton cranes, and is provided with a 330-foot pouring platform capable of handling two sets of molds.

The Bessemer plant is designed for the ultimate addition of a third vessel. Its present capacity may be conservatively placed at 75,000 tons per month of blown metal, Bessemer ingots, or any desired combination of the two. The three tilting open-hearth furnaces when operating on blown metal are rated at 65,000 to 75,000 tons per month. The elasticity of their operation is self-evident, and it is obvious that their actual tonnage is dependent upon the character of the charge used. At the present time two of these furnaces are running on open-hearth material, with Bessemer blown metal as a base.

The other furnace is operating on a nickel steel scrap charge with molten pig iron additions for further refining in the electric furnace.

In transferring open-hearth metal to the electric furnaces, it is the aim to have the metal slightly lower in carbon and manganese than the specifications under which the electric steel is to be made. There is of course oftentimes a wide range in the specifications under which the electric furnaces are operating, involving high and low carbon and various alloy steels.

THE QUESTION OF POWER LOSSES IMPORTANT.

The new electric plant contains three 25-ton Heroult furnaces, each with an adjacent transformer building. The general design and dimensions are shown by the plan and cross sectional views. The capacity of the plant naturally is somewhat dependent upon the character of the steel made, but may be placed approximately at 12,000 tons per month. This, with the output of the two old furnaces, gives a total electric steel capacity of 16,000 to 17,000 tons per month, and makes the South Chicago works the world's largest electric steel producing plant.

The advancement in the design and operation of electric furnaces has not necessitated any radical change in the original electrical scheme as a whole. Such improvements as have been made have been rather in the nature of refinement than essential change. In the case of the large electric furnace, it is more necessary than in the small furnace to consider the losses due to reactance in the electrical current. When we consider the relatively little power required by the original furnaces, it is evident that in the case of our larger furnaces, which are equipped with transformers of 3,750 K.V.A. capacity, the question of power losses is an important one. In respect to the electric furnace load from the central station standpoint, it is interesting to note that with four furnaces operating on the triplex process, 24-hour load

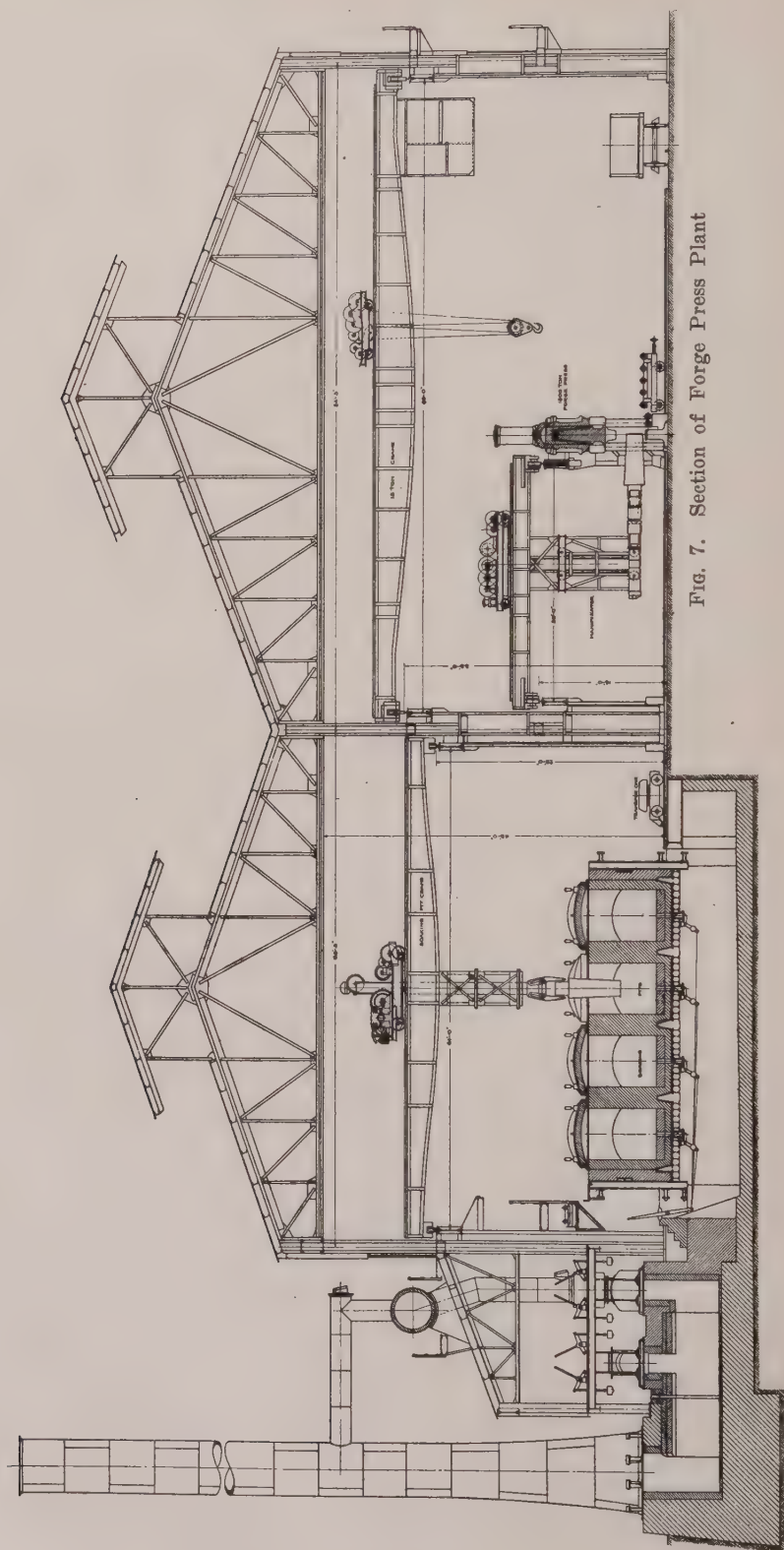


Fig. 7. Section of Forge Press Plant

factors of 75% or 80% are not unusual. This compares favorably with other forms of industrial load.

In our practice the furnaces ordinarily are operated with only a reducing slag, and care is taken at all times to see that such conditions obtain as will most thoroughly and quickly effect complete deoxidization. After the steel is thoroughly dead-melted and the reactions are complete as determined by the careful testing of the slag and metal, the current is reduced until a proper pouring temperature is obtained.

The pouring of steel from the electric furnace is subject at all times to the careful control of pyrometric observation. For the production of a satisfactory steel a proper casting temperature is an important element in all processes, but with the electric furnace special care is needed, partially because of the high heats obtainable with the electric arc. Electric steel, on account of its freedom from gases, is specifically a dense steel, and in metal of this character the pipe tends to be exaggerated. It is our custom to teem all electric steel in inverted molds with refractory hot tops. As a result, little difficulty is encountered with the piping, as usually found in the ordinary ingot.

QUALITY THE SINE QUA NON OF ELECTRIC PRACTICE.

In connection with alloy steels, it is very necessary to guard against any condition that will unduly tend to unequal ingot strains, and special precautions are taken to avoid undue surface tension in the molds. We are now casting ingots weighing from 3,400 to 38,000 pounds, the uniform solidification of which is made the subject of the greatest care. Top pouring, box pouring and bottom pouring are resorted to, as the individual character of the steel best appears to warrant, and the entraining and inclusion of slag or other foreign matter is carefully guarded against.

To one familiar merely with the casting methods in vogue with ordinary open-hearth or Bessemer steel, the

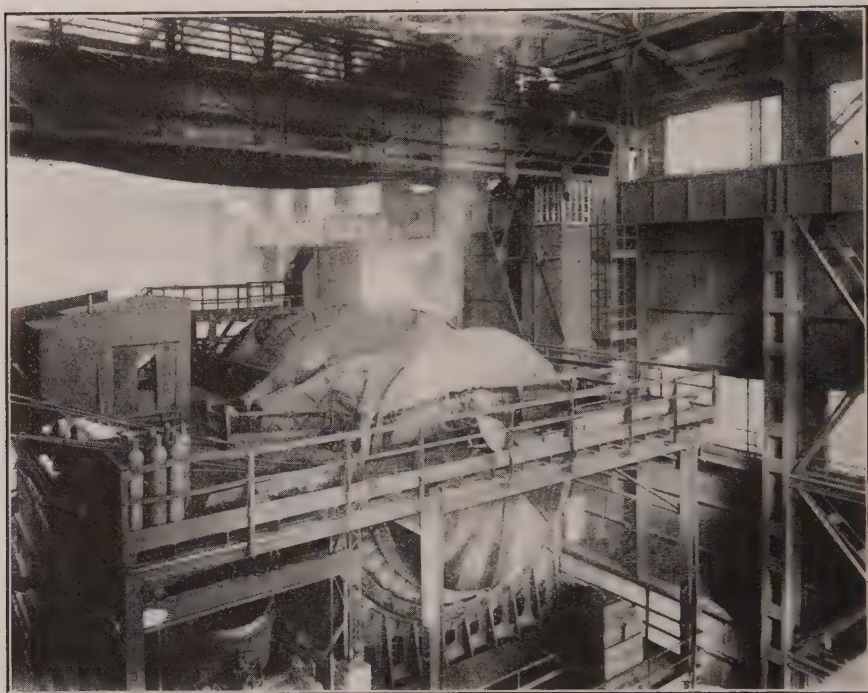


FIG. 8. Pouring Pig Iron Into 1300-Ton Mixer

pit practice incident to the proper manufacture of electric steel is something of a revelation. In the subsequent work to which the ingot is subjected, whether in the forge or in the rolling mill, special precautions are taken in the heating, in the reduction of the metal and in the cooling of the product. Ordinary mill practice will by no means suffice if proper results are to be obtained, especially when alloy steels are concerned. Steel which may be innately of the highest quality when tapped in the ladle may readily retrograde or become unfit unless there is exercised extreme care in its later manipulation. Quality is peculiarly the sine qua non of electric steel, and the price of success is eternal vigilance.

WHEREIN THE SUPERIORITY OF ELECTRIC PRACTICE LIES.

There is, of course, nothing occult nor mysterious in the electric method, although there is more or less mis-

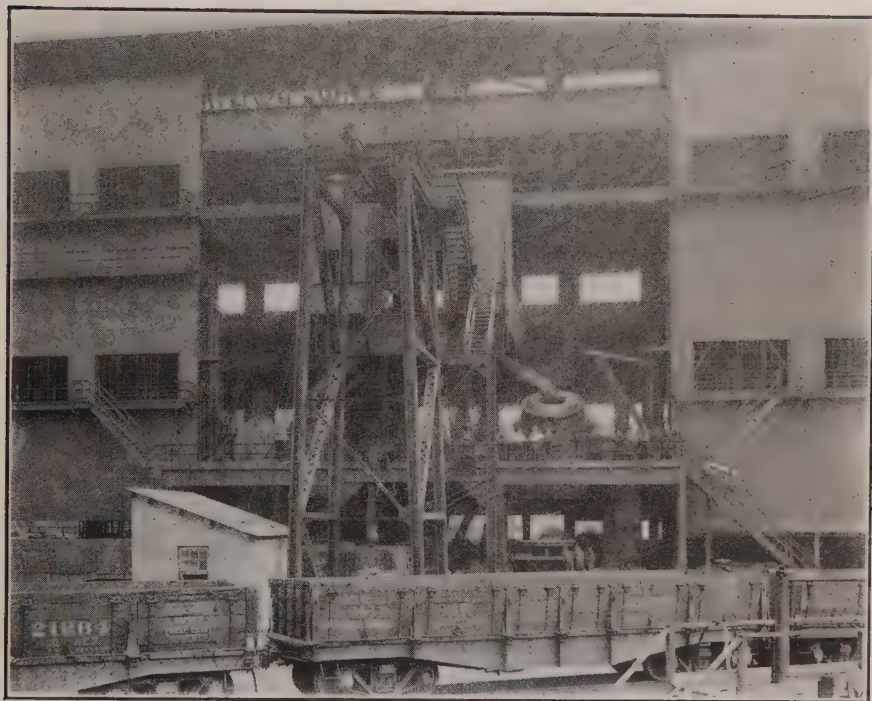


FIG. 9. 25-Ton Vessels in Duplex Plant

conception concerning the production of electric steel. The electric furnace, when used for the manufacture of steel, may be likened to a large crucible heated from within instead of from without by the electric arc. It is capable of performing not only the functions of the open hearth, but very largely those of the crucible as well. Its superiority lies in the rare purity of the heat derived from the electric current and in the peculiar slag control that can be commanded in a neutral atmosphere. Both the Bessemer and the open-hearth processes are distinct in their physical and metallurgical character. The electric process may likewise be considered as distinct when concerned with the manufacture of steel directly from cold metal. When, however, it is used to finish metal which previously has been made in the Bessemer or open hearth, it may be considered as supplemen-

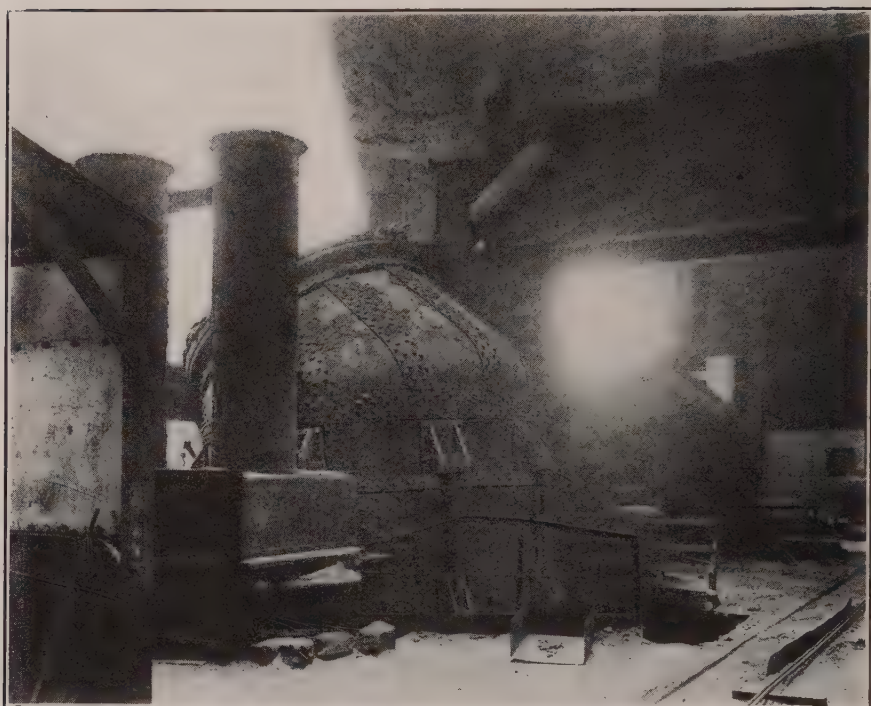


FIG. 10. Blowing Metal in Converters

tary to standard methods rather than as an independent process. Other than as manufactured in the smaller and perhaps more ephemeral installations, electric steel is to-day, and probably will be in the future, largely produced by a duplex or triplex process whereby, strictly speaking, steel is electrically refined rather than electrically made.

The manufacture of steel is far from being an exact science. It is an art founded upon scientific principles, and, to a degree, subject to scientific control. But there is much in the metallurgy of steel that bespeaks ignorance instead of knowledge, uncertainty instead of definite determination. It logically follows that one should not be dogmatic in passing upon the respective qualities of steel made by different processes. As measured by customary chemical and physical standards, it is possible to show



FIG. 11. Pouring Blown Metal Into Open Hearth Furnace

that steel made by the Bessemer process is at times equal in quality to that made by the open hearth, and steel made by the open hearth is equivalent to that made in the crucible. By the same token, it may not be difficult to show that steel made by the open-hearth process is as good as that made in the electric furnace. Certainly some of our laboratory results, upon which we ordinarily depend for metallurgical guidance and control, warrant such an assertion. But just here science, paradoxically speaking, proves unscientific, and the laboratory oftentimes does not square with the results in the field. We all know that irrespective of laboratory tests, the final verdict of result in service has already clearly established the superiority of open-hearth steel as compared with Bessemer, and the superiority of crucible in its own particular field as compared with open-hearth. In the last analysis, the charac-

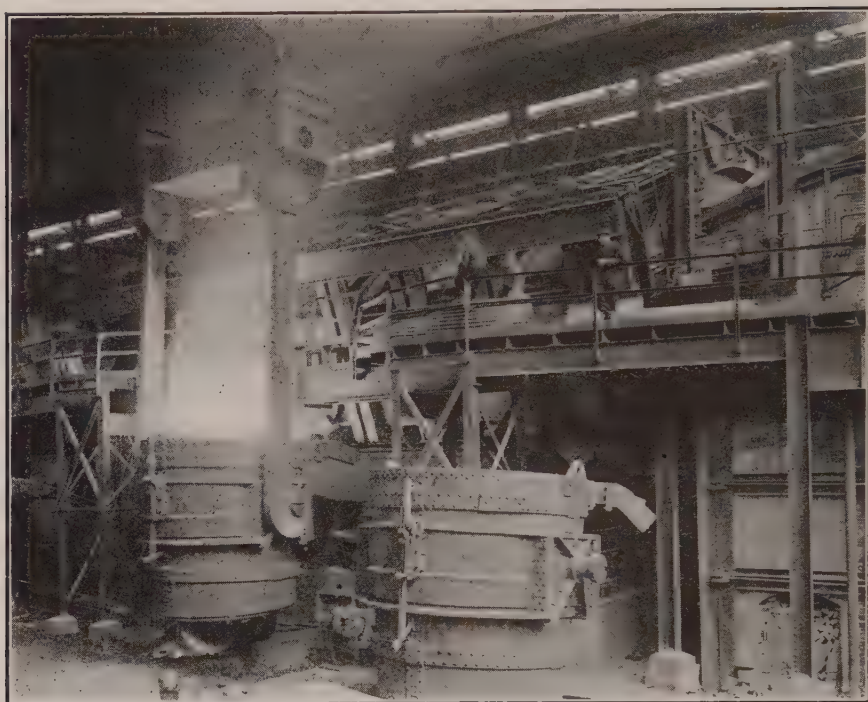


FIG. 12. Tapping Open Hearth Furnace

teristics of any metal must be determined by the composite testimony of practical experience. It perhaps may be argued that, as so determined, the verdict in respect to steel made in the electric furnace is still an open one, because of its comparative youth. Nevertheless, the result of ten years' experience here and abroad strongly points to electric steel being in its natural qualities equal to crucible steel and superior to the steel ordinarily made in the open hearth. As bearing upon this, the testimony of our honorary and honored member, Dr. H. M. Howe, as recorded in his "Classical Metallurgy of Steel," is of interest. Dr. Howe states:

"It is not easy to see why crucible should be better than Bessemer and open-hearth steel of like composition.
* * * Whatever be the reason, there seems to be but little doubt that crucible steel is better than Bessemer

and open-hearth steel of like composition as actually made. * * * The belief in the superiority of crucible steel of like composition rests rather on general observation than on conclusive direct evidence, and it must be confessed that the quality of much of this evidence is not of the best. This, however, from the nature of the case is almost unavoidable, but the quantity of evidence goes far to make up for its quality."

A WORD AS TO THE FUTURE.

And now a word as to the future: I am not unmindful that "A prophet is not without honor save in his own country." Moreover, human limitation and the kaleidoscopic changes of the past make one hesitate to forecast the metallurgy of steel. While ours is the age of steel, it has been given to men here present to see the passing of the age of iron. The crucible is hoary in its antiquity. The converter a short generation ago was but a conception in the mind of a man whom many of us knew personally, and the open hearth as an essential factor is even more striking in its adolescence.

It behooves one, therefore, to be conservative in his prognostication. Forty years ago this country produced but little over a half-million tons of steel, ninety per cent. of which was made by the Bessemer process. Last year we made forty-three million tons of steel, and to the open hearth seventy-five per cent. is to be accredited. While our production of Bessemer steel has remained nearly stationary since 1906, when it reached its zenith with an output of twelve and a quarter million tons, the open hearth has rapidly forged ahead, and last year it accomplished over thirty-two million tons.

The marvelous development in Bessemer steel was due both to its superiority for general purposes as compared with wrought iron and to its relative cheapness of production. The more recent expansion of open-hearth is attributable not alone to changing ore conditions and to the lower cost incident to modern construction, but to the increasing demand for a higher quality of steel. The

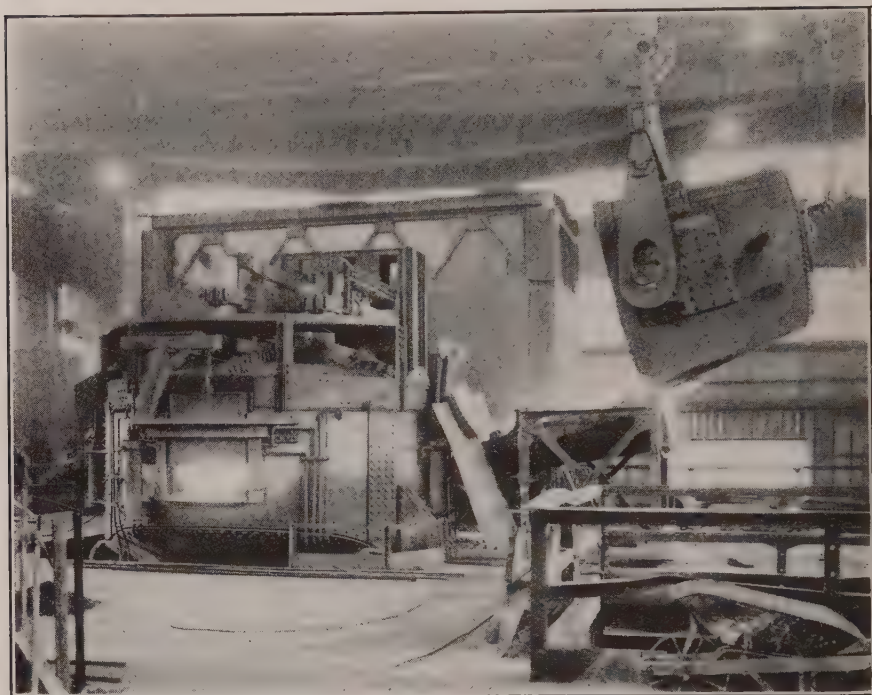


FIG. 13. Pouring Open Hearth Metal Into Electric Furnace

passing of the Bessemer plate and the Bessemer beam and channel was only a prelude to the replacement of the Bessemer rail by its open-hearth rival. It is true that steel made by the Bessemer process is admirably adapted to certain products, and for many years to come will play an important part in the metallurgical economies of our nation; but the glory of the converter has definitely paled before the more enduring reliability of the open hearth. In the earlier stages of our steel manufacture, tonnage as an essential element of cost was a dominant consideration. Neither the mill nor the consumer attempted more than a general differentiation as to the character of the product. It was largely a matter of quantity and price. Now quality stands first, and while tonnage has gone on apace, volume has become more and more subordinate to character of production.

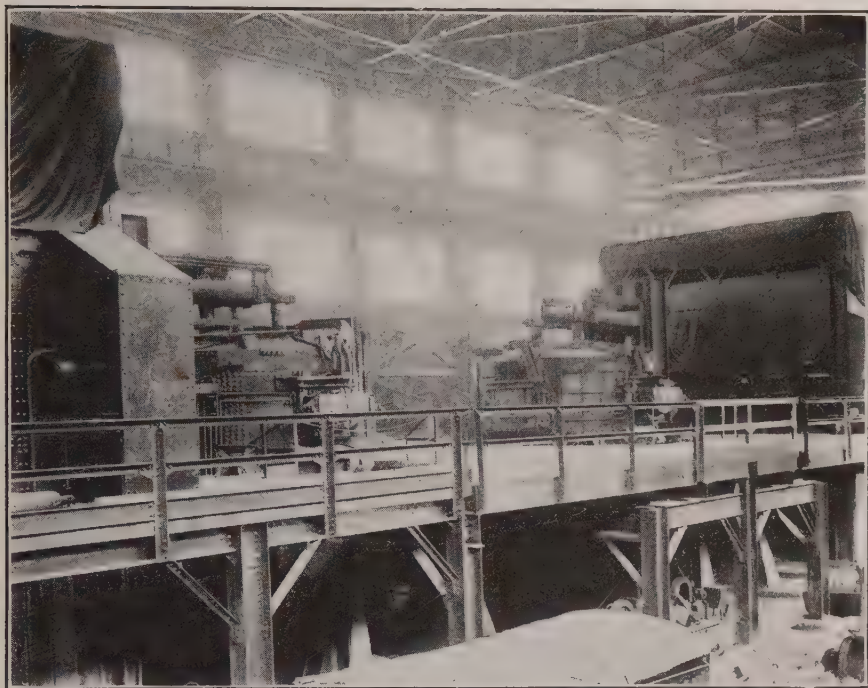


FIG. 14. View of 25-Ton Electric Furnaces

What does this increasing demand for higher quality portend for electric steel? How much is history to repeat itself in connection with the new process? It is clear that the lower the cost of production, the greater will be the field presented, and much will depend upon the iron-master's ability to reduce the cost of electric refining to a minimum. When we realize the economies that have been commanded with the open-hearth furnace during the last twenty years, it perhaps is not unreasonable to anticipate that much may be accomplished along similar lines with the electric furnace. There appears to be no reason why electric furnaces larger than those already installed cannot be built. Cost should be inverse to tonnage, and high quality is not incompatible with large production.

If one is intelligently to read the future, he must take into consideration both statistics and psychology. The



FIG. 15. 1500-Ton Forge Press

annual statistical report of the American Iron and Steel Institute first separately classified electric steel in 1909, with a production of 13,762 tons. Last year this country produced 234,000 tons, which is more steel than was made annually in all our open-hearth furnaces thirty years ago. The output of electric steel this year undoubtedly will be much greater. We are now producing at the South Chicago plant at the rate of 140,000 tons per year, and we shall shortly be producing at the rate of 200,000 tons per year. Our country is growing rapidly, and the per capita consumption of steel is growing even more rapidly. In 1900, our population was approximately 76,000,000, and each of our inhabitants represented an annual consumption of 280 pounds of steel. In 1916, our population had reached 103,000,000, and our annual consumption of steel had increased nearly three-fold, to 820 pounds per

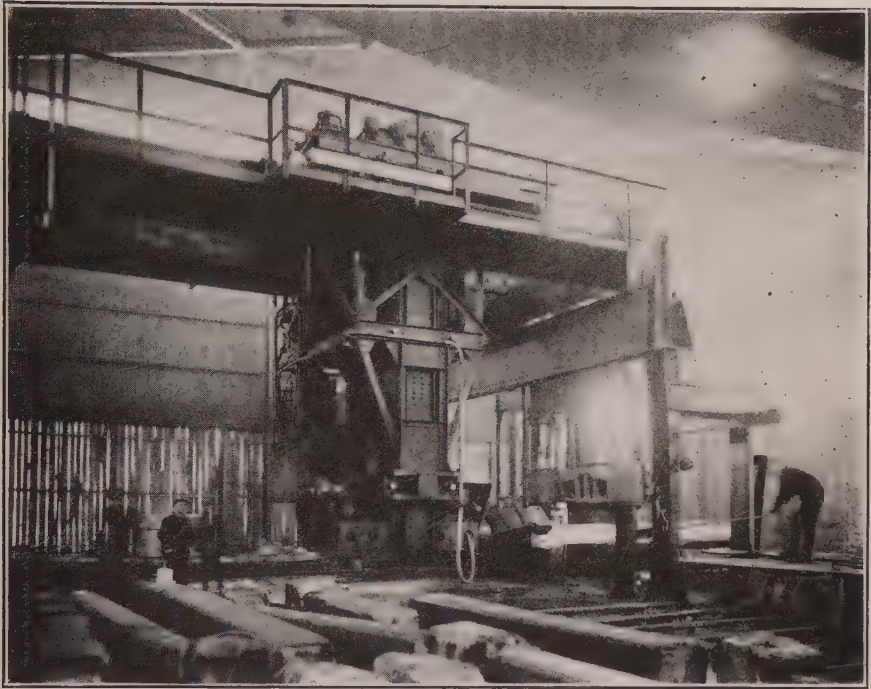


FIG. 16. Forge Press and Manipulator

capita. These figures do not include our exports of nearly five and a quarter million tons made that year. So much for statistics.

As for psychology, we should not forget that the luxury of to-day is the necessity of to-morrow, and that emulation is a powerful creative force. Bessemer steel was eminently satisfactory until the superior quality of open-hearth metal relegated it to a subordinate class. And now comes electric steel with a still higher standard. Safety cannot be measured by price, and public opinion will more and more insistently call for the highest excellence in the automobile, the airplane, and other forms of fabricated material.

Forty years ago Sir William Siemens dreamed of making electricity the handmaiden of the metallurgical art, and through his efforts his dream was realized in the

birth of electro metallurgy. Twenty years later, Heroult visualized the dominance of electro metallurgy in the realm of steel. Whatever the future may have in store, let us remember that progress waits upon vision, and vision, even though it resolves for the moment into a mirage of shattered hope, often is ultimately translated into accomplishment.

Mr. Robinson then illustrated his remarks by means of moving pictures.

VICE-PRESIDENT KING: Gentlemen, Judge Gary has just asked me to relieve him for the balance of the afternoon. Those of you who know Judge Gary best know that people generally do what he asks them to do, so I will have to ask you to accept me as a substitute with what grace you may.

This admirable paper of Mr. Robinson's will be discussed first by Dr. Henry M. Howe, to whom this audience needs no introduction. Dr. Howe will be followed by President Mathews of the Halcomb Steel Company, who is also well known to you. Dr. Howe.

THE TRIPLEX PROCESS OF PRODUCING ELECTRIC STEEL AT SOUTH CHICAGO.

Discussion of HENRY M. HOWE

Professor Emeritus of Metallurgy, Columbia University, New York City.

We never had a very clear and satisfactory explanation of why crucible steel was better than open-hearth and Bessemer, but the evidence was cumulative, and whether with or without a reason we came to accept that as a conclusion which could not be contradicted or doubted, that crucible steel was very much superior to Bessemer or open-hearth. We might speculate as to why that was. Perhaps it was because the atmospheric conditions were better and perhaps because you had better control over the conditions. You can make the conditions more uniform in the crucible process than you can in the Bessemer or open-hearth. When you come to the electric process you find you are of the same mind. You do not see immediately why the electric steel should be better than open-hearth, but then you remember that the conditions in the electric furnace are almost identical with those in the crucible, and whatever it is that makes crucible steel better than open-hearth steel, I think, we have good reason to believe also makes electric steel better than open-hearth steel. At any rate, it grows very much easier for us to believe and to accept the evidence of experience, that electric steel is better than open-hearth steel, from the fact that the electric furnace reproduces very closely the conditions of the crucible, particularly in that it has very much closer control over the conditions. You can get in the electric process much closer control over the conditions than you can get in the open hearth, and very much closer than in the Bessemer. For instance, in the open hearth you have such atmosphere as you can get and such slag as you can get. In the crucible you have such atmosphere as you wish and you might say such slag as you

wish. Such would naturally be the advantage of the electric furnace. It will continue to have an important part in the treating of readily oxidizing metals and alloys, chromium, manganese and so on, and it will play a great part in the production of the alloy steels. But I believe that its greatest part is going to be in just what has been shown to us so clearly and eloquently this morning, in the finishing of steel. It has well been said that if you are to wash a very dirty object you may start with dirty water, but to finish your cleansing you need very clean water. This applies to the electric furnace as a finishing. Here you get a final touch which you cannot get in the open hearth. I believe that the excellence of your product is determined in large part by this final touch. For this final touch the electric furnace is a most fit instrument, essentially because it gives a control over the conditions which is not to be expected elsewhere.

When we consider the quantity of the output to be expected we come to a point where we may give some little rein to our imagination. You turn in many directions and you find that cost is becoming more and more a secondary matter, and the highest possible quality is becoming an absolute necessity. For instance, in the case of body armor. If we are going to arm our soldiers we must give them the very best possible protection which a unit weight of material will give them. So with the armor of ships, you must give the ships the highest possible unit ballistic strength in its armor. So with rails. We are going to put on rails the greatest locomotive which it is possible for a rail to carry. That is to say, low freight rates and cheap transportation are going to depend on enormous and heavy locomotives, and the rails which are to carry these locomotives must have the greatest possible resistance; that it seems to me we are going to get in the electric process. Hence I fancy that the time is not very distant when the standard rail practice will be triplex, to rough or desiliconize and decarburize in the Bessemer, to improve in the open hearth, and to finish in the electric furnace.

THE TRIPLEX PROCESS OF PRODUCING ELECTRIC STEEL AT SOUTH CHICAGO.

DISCUSSION BY JOHN A. MATHEWS,

President, Halcomb Steel Company, Syracuse, New York.

Two years ago I had the honor of presenting to this Institute a paper entitled: "The Electric Furnace in Steel Manufacture," to which Mr. Robinson has referred. In that paper it was my pleasure to report in a preliminary way the notable installation just described and to intimate that the details would doubtless be made the subject of a separate communication by some one intimately connected with this development. That Mr. Robinson's instructive paper fulfills this promise in a most satisfactory way you will all agree. To those of us who have been following the subject for fifteen years or longer it is much more wonderful than anything we dreamed of or contemplated in the early days of the electric process. If the inventors foresaw such developments and disclosed their visions to us, we discounted them and attributed their optimism to the characteristic enthusiasm of inventors.

In the introduction of electric steels for several years when we were alone in the field, we would have been more successful had we *not* been alone, and the case is well stated when Mr. Robinson says, "the luxury of today is the necessity of tomorrow. Safety cannot be measured by price, and public opinion will more and more insistently call for the highest excellence in the automobile, the aeroplane and other forms of fabricated material." It was hard enough to convince users of the superior quality of electric steel in the early days and still harder to get makers of open hearth steels to admit it and it is certainly refreshing when a man so well informed as Mr. Robinson concerning the merits and limitations of Bessemer and open-hearth steels comes out in an unqualified way to endorse what we have contended for many years.

The data submitted as to relative ductility at very low temperatures is instructive and may not be without practical application in connection with aeroplane steels which are frequently subjected to a combination of low temperature, vibration and shock in use that will tax the best materials. Light field or body armor that will withstand the ballistic test at normal temperatures may fail in intense cold. From a close connection with the preparation of specifications for materials for such purposes, during the past year, I do not feel that these finer points have received adequate attention.

Two years ago I said: "Not only in automobiles and aeroplanes, but in many other ways, electric steel will give a good account of itself for military and naval purposes." We can now say that it *has* done so. I know it as regards our own products and I have it directly from those in a position to know about the products of the Illinois Steel Company and of other firms.

We have an electric furnace productive capacity in the United States that could take care of the entire requirements of the aviation and body armor programs, and leave some over for trucks, gun parts and other exacting needs of the Government.

The combination of Bessemer, open-hearth and electric has been called the "triplex" process, while the early use of open-hearth and electric as practiced by us is a "duplex" process just as truly as that of Bessemer and open-hearth to which the term is generally applied. Contradictory as it may seem, I think that the apparently simple method of direct cold melting and refining in the electric furnace might be called the "complex" process, for I believe that making consistently uniform, well-melted steel direct from low grade scrap, with the use of two slags, requires greater metallurgical skill and persistent care than are required by either process where a liquid base and only one slag are employed.

The very high load factor, reported in the paper under discussion is quite remarkable and I should like to ask the

author if his figure is based upon connected load or upon a peak load basis. Upon the latter basis we have not been able to equal this load factor.

Over forty years ago Sir William Siemens stated that the function of electric melting is to "effect such reactions and decompositions as require for their accomplishment an intense degree of heat, coupled with freedom from such disturbing influences as are inseparable from a furnace worked by the combustion of carbonaceous materials."

Several results follow because of this which are of vital importance just now. Easily oxidizable metals like vanadium, chromium and manganese are readily handled and hence less of them need be used to give a final minimum content in the steel. Also, there will be less of the oxides of these metals produced in the steel and to be removed from the steel. Sulphur and phosphorus can be readily eliminated and it is obvious if they are essentially absent they cannot segregate. Therefore, cropping may be reduced and yield increased—practical conservation!

Alloy additions may be made in the furnace rather than in the ladle thereby increasing solution, diffusion and homogeneity.

All of these considerations make for quality when quality is the first consideration, and beside, the electric furnace performs an economic function from its adaptability for handling and recovering alloy values. With the chromium and manganese situation as it is, this ought not to be overlooked. Some alloy scrap is not a desirable addition to open-hearth furnaces, or, if made, a large share of the alloy is lost in the slag. It is highly desirable just now that no alloy material be lost.

One more economic consideration may be mentioned. With wise State and National policies affecting hydro-electric developments, we may see a great electric steel industry develop without impairment of coal reserves. There are indications that the Government is taking a more enlightened view in regard to developing or permitting the development of those great and inexhaustible

natural sources of power—the waterfalls, and when such developments are accomplished the electric furnace will utilize power which, once over the falls, is gone forever, to reclaim materials that in fuel-fired furnaces are irretrievably lost, and produce the maximum yield of particularly sound steels necessary to the advancing demands of war and of the longed-for peace.

VICE-PRESIDENT KING: Gentlemen, we are going to have a change, or rather an addition to the regular program. Secretary Lane of the Interior Department, has sent Mr. H. H. Wheaton of that department, who will speak to us for five minutes on “Americanization.”

PROMOTING AMERICANIZATION

H. H. WHEATON

Interior Department, Washington, D. C.

Mr. Chairman and Gentlemen: I did not come today to present to you so much the subject of Americanization, as a bill which has been drafted to deal with this subject upon a nation-wide basis, and we need at this time the support of this body and of the industries represented here in getting this bill before the country.

You all know that Americanization is before the country as a war measure. On April 3rd we had a meeting of Governors, Chairmen of State Defense Councils, representatives of the industries and Chambers of Commerce, called by Secretary Lane. At this meeting we agreed upon some fundamental propositions. Two bills have been drafted, one a very short bill to take care of emergencies and the other a real bill to deal with the subject of Americanization.

We have, gentlemen, five million persons in these United States who are unable to speak the English language. These men are employed in your industries, fifty-seven per cent of them in the iron and steel industries. Almost as large a percentage is in the bituminous coal industry, and other industries indispensable to the conduct of the war. Eight million foreign born persons are engaged in gainful occupations in this country. Supposing, gentlemen, this second line of defense, the industries, should be compelled to reduce production or to slow down production because of the indifference, the antipathy of the foreign born worker of this country. It takes many men back of the firing line in France to maintain that line, to produce guns and munitions and coal, etc., and many of these men today in this country, are foreign born, and a great many of them owe no allegiance to the United States Government.

Now, this is a serious proposition which concerns us industrially from the standpoint of the war. National unity depends on a common language, a common understanding of the ideals of this country. To train these people, therefore in the use of the English language, in our common ideals, in our history and in our citizenship, is of important significance today. Hence, we have drafted a bill, a Federal Aid Bill, for the purpose of assisting the communities and the States and the Industries of this country, and voluntary associations of various kinds, in carrying on this work. This bill appropriates the first year five million dollars outright for this purpose, to be distributed among the several communities upon the basis of the number of individuals who speak no English, who are unable to speak English within the quarters of each State. The State is not required the first year to put up an equivalent sum of money. The second year the National Government is to appropriate three millions, the third year four, and the fourth year five millions. various factories where the men are employed. There After the first year the State has to put up an amount equal to that put up by the Government. We prescribe in this measure that fifty per cent of the money appropriated shall be applied to the training of foreigners employed in the industries. The largest percentage of this money, of course, would be spent in plant classes in the are other provisions of interest, such as that \$750,000 of this money is to be spent annually to train teachers to do the work, and so on; but this is the substance of the bill. It will be an appropriation to the States of this country large enough to make it worth while to do Americanization work and to insure the States and communities putting up an equal amount of money to carry it on intelligently and strongly. Heretofore we spent only a few thousand dollars in Americanization. We have tried to Americanize thirteen million foreigners by the expenditure of a few thousand dollars, until the time has come when we must as a country go into this proposi-

tion and meet it financially and meet it as a national issue and as a measure of war. (Applause.)

I therefore ask, if it is proper for me to do so, if you can pass some resolution or expression of endorsement of the principle of the policy contained in this measure. I haven't the time to explain the details to you, but have outlined the general principle upon which we are acting. We are following out the spirit and the tenor of the meeting of April 3rd at Washington when this subject was discussed, and we need and seek the co-operation of the industries, commercial organizations and industrial organizations of this country. We need, of course, the support of the Labor Unions, and we have this pledged from them through Mr. Samuel Gompers, for these bills. We need also the co-operation of every American citizen, of every State Council of Defense, of every unofficial society, so that this measure may be enacted into law at the earliest possible moment, so that in the interests of national unity, gentlemen, we may deal with the foreigner in our midst and make this country of many people—one United States. (Applause.)

A VOICE: What is the number of that bill?

MR. WHEATON: The bill has been placed in the hands of Senator Hoke Smith for introduction this week. It will then receive a number.

THE VOICE: Mr. Chairman, if it is in order, I move we take up this resolution.

A VOICE: Seconded.

MR. KING: While I believe that there is really nobody here who would not gladly vote for that, the usual method of procedure in matters of this kind is that they come through in a regular way to be considered by the directors and then the members of the Institute be consulted. It seems to me that would be Judge Gary's ruling if he was here, unless there is an overpowering request to settle the thing now. There is a motion before the house, duly seconded, but we usually do not take it up in that way.

DR. MATTHEWS: I amend the motion, with the sugges-

tion that the motion be referred to the directors of the Iron and Steel Institute with power to take action.

A VOICE: I second the amendment.

MR. KING: You have heard the amendment; are you ready for the vote?

(All answer yes.)

The amendment was thereupon passed by the unanimous vote of the members present.

VICE-PRESIDENT KING: We will now have a paper on the Relation of the Trade Papers to the Iron and Steel Industry by Mr. Stephenson of M. A. Hanna and Company.

RELATION OF THE TRADE PAPERS TO THE IRON AND STEEL INDUSTRY.

BERTRAM S. STEPHENSON,

Resident Agent, M. A. Hanna & Co., Pittsburgh.

Not later than the 6th of June we shall know the tonnage of pig iron produced during the month of May. *The Iron Age* and the *Iron Trade Review* will have this information available in their issues of that date. It will have to be compiled rapidly, for the most part by wire, but it will be accurate, as may be demonstrated when the American Iron and Steel Institute publishes its statistics, in elaborate detail, for the six months' period.

This is but one of the many substantial services rendered by the trade papers. One regularly records ore tonnages on lower lake docks. Another, a weekly, reports coke shipments from the region. All through the summer and fall we shall trace through them the progress in the Great Lakes traffic on which this industry so largely depends. Within a few weeks after navigation closes, we shall know the tonnage shipped from every mine on the Superior Ranges.

These services, along with countless others, are accepted as a matter of course, for the trade press is one of the things which American industries commonly take for granted. It has been with us since the days of Bessemer and Kelly, the beginnings of bee-hive coke and the epoch-making shipment of those first few barrels of ore from Marquette. It has developed along with and as a part of the industry, which perhaps explains why we are sometimes prone to overlook its advantages and possibilities.

In describing its province, some one has said that the trade journal bears exactly the same relation to the newspaper or general magazine that the engineer or technically trained man bears to the average citizen. It is a specialized newspaper, fitting naturally into the modern

scheme of specialized business. Occasionally this specialization runs to rather curious extremes. There are such publications, for instance, as the *Macaroni and Noodle Makers' Journal*, the clientele of which is obvious; *Brooms and Handles*; the *Crow Bar*, which reports 4000 blacksmiths as subscribers; *Sunnyside*, which is a leading publication for undertakers; even the *Angora Journal*, which aims to record everything of interest regarding that particular kind of goat.

A Newark library recently held a trade-journal exhibition and showed 1200 publications without presuming to exhaust the list. "Put several hundred such publications together in a small room," commented the librarian, "and you get an effect wonderfully similar to that produced by several hundred business men in a large room." They are dressed in varying degrees of good taste—some of them a little loud—but all of them, always and everywhere, cheerful and optimistic. This, at least, may be set down as a universal trait of trade papers.

This Newark librarian had original ideas of publicity. By his own admission he did not hope to attract many men of his own city to the exhibit. But he did figure on getting it advertised elsewhere, so that Newark men would hear from the outside world that something worth while was happening there. "That is the kind of advertising which reaches the Newark man," he observed, "even though it is a very slow process. What we are trying to do is to impress our manufacturers and business men with the amount of current information on their trades. We want to make it available for them and we want especially to foster the *trade-journal-reading habit*."

THE TRADE-JOURNAL-READING HABIT

The trade-journal-reading habit! Mark Twain once remarked that he had lived in the world a long, long time and he knew one must not judge an editor by what he put in his paper. But even if we were inclined to accept the humorist's suggestion, many of us would not be in posi-

tion to judge, for we have no idea what the editor does put in his paper. In fact, so far as most of us are concerned, it is hardly accurate to speak of the trade-journal-reading habit, but rather of the trade-journal-*skimming* habit. And yet our trade and technical papers, to quote Mr. Hurley, are the best in the world. They are tools of the industry and they are made to be used.

Doubtless 95 per cent of the Institute members regularly see or have immediate access to the leading publications serving this special field. A goodly portion will say they are "regular readers"—and some of them are. But for far too many of us this reading is of only "a lick and a promise" variety. Probably on an average it amounts to a rather careful survey of a column or two of general market summary, a hurried scanning of certain special market reports in a few important centers and perhaps a casual glance over the personal and obituary items to see whether any business acquaintances are involved in developments of a noteworthy character. Possibly some pictures may catch the eye or some special article hold the attention for a moment before the paper is tossed aside—exhausted.

This estimate is not an exaggeration. The trade papers are read somewhat more carefully in quiet times, more hastily or not at all in busy periods, but this is a fair average and indicates our general neglect of a service of which our foreign competitors show a full appreciation. Their size is awe-inspiring, it is true, some of them approaching the bulk of a mail-order catalog. But, as a matter of fact, the weekly publications will average about 64 pages of reading matter, because they are edited with the ever-present idea of condensation. Every line of every page is written with a view to reporting accurately some fact, condition, process or accomplishment of interest either to some special field or to the industry as a whole.

We are told that recently some 17,000 homes were visited in the course of an investigation as to the publica-

tions read by consumers in a certain district. In one particular home it was found that the publications read were the *Butchers' Review*, the *Police Gazette* and the *Christian Herald*, furthermore, the *Christian Herald* in this case was read by the cook. Now the point is that these papers were read *in the home*, and it is perhaps pertinent to suggest here that an occasional evening spent quietly at home with your favorite trade paper, whatever it may be, will show results both surprising and profitable.

Besides the strictly technical articles, one will find there much general material of timely interest. For instance, I believe the first satisfactory description of the Browning gun appeared in *The Iron Age*. Likewise the *Foundry* explained the manufacture of the improved rifle grenade which our malleable shops are now turning out by the millions. Recently a column of facts and figures in another publication, detailing the iron ore reserves of Alsace-Lorraine, Luxemburg and the Briey Basin made clear the motive governing the direction of the first German drive in this war of steel. And these examples might be multiplied indefinitely, but the intention is merely to emphasize the appeal which the average trade paper can make even to the non-technical reader.

A year of war has recast business methods; it has also shifted our centers of news. During that time, as our industries have admitted Uncle Sam—first as a by-no-means silent partner and later in the capacity of managing director—Washington's position as a business news center has become supreme. The trade papers were quick to appreciate this new condition and one can now look to them for industrial-war news which is at once dependable, technically accurate and free from political flavoring. In particular, their reports of the many investigations which have stirred Washington and the country these last few months, carefully written from the business man's viewpoint, have been refreshing in contrast with the reports in the daily press. And in certain directions it is not too much to say that a careful reading of

these business papers during the winter might have saved many of us from the hazards of crowded sleepers and Washington hotels.

I hold no brief for the trade journals and the idea here is not to catalog their offerings, but rather to suggest that they merit our better acquaintance. I recall that, a dozen years ago, the owner of a small, isolated blast furnace remarked that he regularly read the several important publications touching his special field. His theory was that, if in the course of a year he could glean from them one good idea applicable to his plant, he would be well repaid. Today his furnace is the last word in equipment and efficiency and his business is highly successful. This plan of closely watching the technical press for practical, working ideas is now followed by many progressive concerns. Ordinarily it consists of a regular, systematic reading by the various executives and heads of departments. Suggestions are noted on a convenient cover slip and these are later discussed at regular conferences, frequently with the result of important improvements and economies. The plan deserves general adoption.

SOME USEFUL SERVICES OF TRADE JOURNALS.

For many years the industry has found it convenient to use trade journal quotations as a basis for sliding-scale contracts. Pig iron and coke, ingots, billets, sheet-bars and other forms of semi-finished steel, copper and other non-ferrous metals, ingot molds, even gray iron castings, are among the products commonly distributed on such an arrangement. There is no means of estimating the volume of business now handled in this way, even in any one line of production, but it is always substantial and at times surprisingly large. During the chaotic price conditions of the early war period, when precedents were being swept away and new levels reached week by week, there was a very extensive recourse to this basis of dealings, as offering the only plan sufficiently flexible to conform to the feverish gymnastics of war-time markets. It

fitted in with Horace Greeley's sage observation of us, the American people, that "our foresight is not so good as our hindsight by a darn sight."

Just now, because of Government price control, the sliding-scale is less extensively employed; yet it is interesting to note that, even during the last calendar year, a single producer in western Pennsylvania supplied a neighboring melter with \$12,000,000 or \$13,000,000 worth of pig iron invoiced on this flexible basis. When the Government schedule was announced in September, the price on this sizable tonnage immediately dropped from around \$55 to \$36.30. The furnace interest, of course, had realized high prices much earlier than its competitors, which were selling on a flat-price contract basis, hence its acceptance of the Washington scale occasioned no great hardship. The fact that the agreed prices automatically became operative on the heavy volume of products moving on sliding-scale contracts was an important factor in their prompt acceptance and scrupulous observance by the entire industry.

The sliding-scale system testifies to the accuracy of trade paper quotations. Incidentally, as well, it increases enormously the responsibility of the editor. In every issue he must tabulate his ideas of current prices, whether or not they happen to be sharply defined. He knows that every variation of 25 or 50 cents immediately multiplies itself by tens of thousands of tons, to the unfair advantage or disadvantage of some one. Actually he serves in the capacity of referee or arbitrator and, in the interests of justice, should have all available information at his command. Yet too often the trade journal men find themselves compelled to pry out the facts from grudging witnesses, to content themselves with half-facts and to piece together scattered bits of obscure information in an effort to arrive at exact market conditions.

To my way of thinking, the point of view which necessitates such methods of news-gathering is radically wrong. It is an inheritance from the dark ages when, in

the nature of things, every competitor was an object of suspicion and distrust. Now it is only a fair proposition that, if your business or your industry uses the trade paper quotations in this intimate way, their representatives are clearly entitled to enough of your time and confidence to put them in possession of such facts as have a direct bearing on the current market. For obvious reasons there are always certain developments on which publicity is out of the question. But the biggest men in the industry came to realize, a long while ago, that the trade press would respect their confidence absolutely. And they learned, as well, that the representatives of these papers would welcome a knowledge of facts which, while they could not be printed, still could be kept in mind in shaping quotations on which they had a bearing. In these latter days the industry has come to regard the trade paper man as one gifted, not with a fine sense of rumor but with a finely developed sense of honor and discretion.

It naturally follows, though indirectly, that the buyer or seller who imparts either information which is untrue or half-facts which mislead by reason of what they do not tell—this with the idea of manipulating quotations—should be set down as one whose methods of trading should very properly be watched.

NEW FIELDS OF USEFULNESS.

Our entrance into the war opened up to the business papers of the country a new field for substantial service. On the first two Liberty loans they contributed more than 7000 pages of advertising and editorial matter. Late in November the Secretary of War sought their assistance in recruiting mechanics and skilled workmen for the Aviation Section of the Signal Corps. Only a few weeks then remained until the draft became effective, and the War Department intimated it would be well satisfied with 12,000 men before that time. The number actually secured was around 43,000.

Early last summer the War and Navy Departments

were in urgent need of machine designers. A four months' search had produced 40 and the task was then delegated to the editor of the *American Machinist*. Visiting some 17 machinery manufacturing centers, in 12 days, he rounded up over a hundred designers and persuaded their employers not only to loan them to the nation, but also to pay the difference between their former salaries and the Government limit of \$1,800 per year.

It is also worthy of note that the farfamed Liberty Motor had its origin in a trade paper idea. An automobile journal sent a representative to France and England to study aeroplane motors. He found some 30 types in use. Parts were not interchangeable and men familiar with one type could not operate the others. Astounded at the confusion and loss of efficiency, the editor laid these facts before the proper authorities at Washington, suggesting that America should concentrate on one standardized type. The Liberty Motor was the result.

Regiments of road-builders, miners, railway operatives, quarry-men and lumbermen—to mention only a few—have been recruited largely through the efforts of the trade papers in their appropriate fields. These journals have been a vitalizing force in the several national campaigns for Red Cross and other relief funds. They have helped to mobilize, to readjust, to energize. And particularly during these last 12 or 14 months the work of the iron and steel publications has been such as to assist and to inspire. They have caught and reflected the spirit of that industry which, we are proud to believe, has led in its whole-hearted, enthusiastic response to the war needs of this nation and its allies.

CONCLUSION.

A year of war has nationalized American business. It has brought a new ideal to dominate our industrial life. It has discarded the old-time considerations of profit and competition and has substituted a new-found incentive which is infinitely bigger. Its demands have speeded up

the development of manufacture and trade, so that revolutionizing changes are now made, not in decades, but almost in days.

Along with these new conditions the war has created a difficult situation in which a diminishing labor supply faces an imperative need for increased production sufficient to offset the things consumed and destroyed in carrying on the conflict. While it is on, and when it is over—when we enter that coming commercial struggle which some one calls “the war after the war”—the measure of efficiency will determine the success of any business or any industry. And greater efficiency, as a well-known editor has suggested, “necessarily means closer as well as keener interest in the experiences of others, livelier appreciation of new ideas, inventions and readjustments of methods. These constitute the very merchandise traded in by the business papers.”

Already they are pointing the way in many problems dealing with the labor situation. We need go no further than the *Bulletin* of the American Iron and Steel Institute to find whole issues devoted to some phase of the question—safety appliances, model gardens, workman-owned homes and other matters of working and living conditions which go to make the laboring man interested, contented and self-respecting. It is a hopeful sign that scores and hundreds of American business papers have taken up this important work. There is no denying the force of persistent publicity and, when it is coupled with the directional force which comes from a constant interchange of practical ideas, sure and steady progress is certain.

A few months ago a convention of trade journal publishers was held in Chicago. It was featured by an exhaustive discussion of the editorial side of their business, and running all through it we find special emphasis laid on what is termed “the creative idea in editing.” “Sitting in an editorial sanctum is a wornout method,” said one of the speakers. “Business papers are now best

edited from the field, and preferably in the shirt sleeves.”

The old theory was to print the news, just the news and nothing more. Then the trade paper lived on its industry. The newer vision is that the trade paper has a far broader service to perform, a mission of leadership in helping the industry to shape its course. When it accomplishes this, the trade paper truly lives *for* its industry.

VICE-PRESIDENT KING: This admirable paper will now be discussed by Mr. A. O. Backert of Cleveland.

RELATION OF THE TRADE PAPERS TO THE IRON AND STEEL INDUSTRY

Discussion by A. O. BACKERT,
Vice-President, Penton Publishing Company, Cleveland, O.

Mr. Stephenson has so ably presented the arguments for both the prosecution and the defense that there seems to be little left to say on the subject. However, I have a short brief here on which I would ask your indulgence.

If you can imagine the existence of the iron and steel business without its trade papers, or the publication of the iron and steel trade papers without the great business of which you are a part, you will establish the relation that the one bears to the other.

Let us first consider your industry without its trade papers. A condition of chaos would reign. You would grope in the darkness of misinformation or no information. You would be isolated almost as completely as the far-famed inhabitants of the South Sea Islands. And without the trade papers you would be the target for the insidious, yellow-dog enemy propaganda that blaze-up in the byways while the spotlight is turned only on the highways. Progress in manufacturing methods would be halted and industry again would return to the era when the secrets of the arts were handed down from father to son. This is assuming much for the province of the trade papers, yet it might be said, with becoming modesty, that there is much to assume.

And as for the iron and steel trade papers without the iron and steel business, there simply would be none.

But the term "trade", in its reference to these publications long since has been consigned to the discard. It smacked too much of barter and exchange. It recalled too vividly to the publishers the day when the paste pot and the shears were the editor's principal weapons of offense and defense. It reminded them also of that

oleaginous, silk-hatted, frock-coated individual whom they employed in the guise of an advertising solicitor, but who instead accepted alms from the manufacturers, which were bestowed with grudging charity. But the paste pot and shears long since have yielded to the editorial staff of highly trained, energetic, up-to-the-minute news gatherers. The editor has discontinued the sport of entering the seat of his trousers in a friction contest with the seat of his chair, while Silk Hat Harry has been replaced by the advertising specialist who is versed in business building by properly-directed publicity aimed only at the man who is interested. This has been the evolution of the trade paper to the business paper and the business papers of the iron and steel manufacturers, in influence, scope and importance have paralleled the progress of and measure up to the great metal-working industry of which they are a component part.

THE PROVINCE OF TRADE PAPERS

What is the province of these publications? To disseminate news and information in a specialized field. To record the improvements in processes of today that will be the standard textbook practices of tomorrow. To present the experiences of one manufacturer so that the other may profit thereby. To point out to the industry loftier ideals to be striven for but never attained. And as so aptly stated in a quotation in Mr. Stephenson's able paper, "these constitute the very merchandise traded in by the business paper". As merchandise it must conform to the latest and most modern styles and these change every day, every week or every month, depending upon the frequency of publication.

When you build a blast furnace you expect to operate it day in and day out, year in and year out along definite, standardized lines. You occasionally make a cast of off iron or blow off the top of the stack, yet your practice remains the same—it is standardized. The same is true of your mills, your steel furnaces and your converters.

Now contrast your methods with those of the publisher. He cannot shut down for relining or because of a breakdown. His paper must be issued at the specified time regardless of contingencies. His publication cannot have an off-cast, since every inaccuracy will be caught by thousands of eyes. When one issue is off the press another must be constructed immediately. It must be fashioned to a different pattern than the previous number. It must have a new style, different make-up, and if possible a greater appeal than the previous issue. The publisher's practice is just the reverse of standard.

The successful editor of a business paper must be a human paradox. He must have no friends. He must have many friends. He must have no friends in the sense that his loyalty to them would warp his better judgment. He must have many friends upon whom he can depend as reliable sources of news and information. At one glance his vision must take in every point of the compass, for he has a solemn duty to perform alike for the backwoods foundryman and the producer of millions of tons of steel. Both are purchasers of the only merchandise at the disposal of the editor, and the interests of both must be conserved.

Before Uncle Sam wiped out the law of supply and demand as affecting iron and steel prices, the editor of the iron and steel paper held a position in no man's land, a target for sniping buyers and sellers. In a declining market he was assailed by the producers; in an advancing market, by the consumers. He was damned if he did and damned if he didn't. But government control has brought him relief and, temporarily at least, he is enjoying a much needed rest from the barrage that both sides formerly directed toward him.

For every human being the editorial sanctum of a publishing house holds enticing allurements. We all like to see our thoughts in print. Every one of us, at some time or other, has cherished the conviction that he could write a play, sing a song or write for publication. And the

latter desire occasionally also adds to the pleasantries of the editor's otherwise prosaic existence. When he receives a manuscript accompanied by a request that not one comma be changed, despite obvious grammatical errors, he must assume the role of a diplomat to appease the contributor. Yet communications and articles are invited and keenly sought and it is unfortunate that our American iron and steel manufacturers have been so engaged with the business at hand that they have not developed the writing habit to the same extent as men similarly employed in other important iron and steel producing countries.

Recently much ado has been raised over the paucity of text matter in our business papers as compared with the bulk of advertising. The business paper only performs its function when it builds for the busy business man. Reams and reams of manuscript are condensed to meet the needs of the reader whose time is drawn upon more heavily today than ever before. Twice the number of editorial pages could be printed, but with no obvious advantage when the information can be presented more effectively in one-half the space. The iron and steel business paper is the fine-meshed screen through which news and information of value to the trade is sieved.

Long before the business papers of your industry attained their present place of importance and value, the great iron master, whom we all love and esteem—Andrew Carnegie—was outspoken in his warm and wholehearted appreciation of the function performed by them. You too have come to a like conviction as evidenced by the kindly receptions you accord both their editorial and advertising representatives.

THE ACHIEVEMENTS OF THE TRADE PAPER

The business paper is so busily engaged directing attention to the developments of the day and the deeds and accomplishments of others, that its own great achievements pass unnoticed. Nearly two decades ago a strike

of steel workers beset the industry. It was known among steel manufacturers that the number of men engaged in this strike as stated by the daily press was grossly exaggerated. But in the absence of definite information these misstatements could not be corrected. It was one of your business papers that dug out the actual membership of this organization and it had the temerity to print these figures. These showed a shrinkage of over 2000 per cent as compared with the fiction fed to the daily press. Nor did this trade paper consider it had performed its function with its publication of these figures. Its editor saw to it that they were distributed broadcast by the news agencies, with due credit to the business paper. These figures were accepted without question by the news agencies because of the established reputation for accuracy of the business paper that gave them out. And public sentiment, when it realized how it had been duped, was crystallized against this strike which soon faded into the horizon.

To serve at all times the interests of producers and consumers, large or small, is the greatest function of the iron and steel business paper. Information frequently is printed that hurts either maker or user. A case in point is the practice indulged in at one time of granting a concession to certain organized steel consumers for their year's requirements, which was not given to others. Every effort was made to conceal this practice and the news gatherers for the business papers displayed equal zeal in attempting to obtain accurate information concerning it. And the information was obtained and was published. It resulted in concessions all along the line and represented great financial losses to the steel producers and proportionate gains for the consumers not previously preferred. This practice long since has been discontinued. It is an adage of the editorial departments of the business papers that information concerning a transaction, regardless of how carefully guarded, is obtainable if sought for diligently enough.

Within a year the entire phase of the iron and steel industry has been changed and with it every phase of the publication of its business papers. The bulwark of their market quotations has been unrooted and replaced by prices fixed by the government. The center of activity has been transplanted from Pittsburgh, New York, Chicago and Cleveland to Washington. Not content to follow, the business papers lead in this great transition. Editorial offices already established at Washington were enlarged to cope with the ever-growing importance of this center. With the rapid-fire changes that affect every previous method of business conduct, the iron and steel papers are serving a greater function today than ever before in their history. It is to them that the manufacturer turns for information concerning almost over-night developments, and it is in them that he places his trust because of their established reputation for accuracy.

And in this and other ways the iron and steel papers are serving their country. When every producer and consumer of iron and steel products in the land was hungry for every bit of news concerning agreed prices the business papers furnished it to him. They sought out every hamlet and village where iron or steel was fashioned and carried the information to the manufacturer, wherever he was located. No agency is provided for the dissemination of this vital information other than the business paper, nor could any other agency be conceived that would perform this function so quickly, so efficiently or so economically.

Wherever the fortunes of this great conflict lead, the business papers will follow. They know their duty and may be depended upon to perform it, whatever contingencies may arise. And the business papers of your industry join you in pledging to the government their supreme efforts and their every resource to win this war.

CHAIRMAN KING: Is there any further discussion under the five-minute rule? (Mr. Penton rose.) Mr. Penton.

RELATION OF THE TRADE PAPERS TO THE IRON AND STEEL INDUSTRY.

Discussion by JOHN A. PENTON,

President, Penton Publishing Company, Cleveland, O.

While I wish to compliment both of the gentlemen on their papers, still there seem to me to be some things unsaid.

I think that Mr. Stephenson strikes a note that is rather pessimistic with reference to the extent to which the class publications of the country, adapted to the iron and steel business, are closely read. I think he failed to note the extent to which we hear of it from all sources and from every direction, and I think that that is true with the average subscriber of the average class publication devoted to the iron and steel industry. He reads the columns of these publications very closely and very thoroughly. I do not think that is true with the big man in charge of operations, but I believe that the average publication, delivered to the average subscriber, is read very thoroughly.

And I am inclined to think, also, that some of the great success of the iron and steel industry in this country is in some measure the result of the dissemination of information in the last 25 years.

With reference to the new enterprise, and with reference to the new processes and new methods, they have all been printed largely in the class publications, if it is devoted to its business; and I think, therefore, that the business has well paid a great debt to the publications.

Mr. Backert said in his paper that, because now there was a end to the news that had been so largely the predominant feature of the class publications, the markets, owing to the universal extent to which the government has regulated and has taken over the matter of price, dis-

tribution and production. It seems to me that there is now a very much greater opportunity for service on behalf of the class publications than ever existed for it in the past. I refer to the necessity of furnishing the iron and steel trade generally with accurate and dependable information concerning the changes which are going on in the industry, and with which I sometimes feel the entire industry is not as well informed as it should be. I feel that way from the character of the questions I hear, from the correspondence that I see, and I was reminded of it to-day at luncheon when one of the most eminent men in the steel industry, a man that stands as high as anybody, a man whom you all know, said to me, it was surprising the extent to which people ought to be ordinarily well informed, yet they travel a long distance, will write letters or call on the telephone or telegraph to find out something or other in connection with the government distribution of material, which he thought everybody knew. I think that is due much to the ever-changing conditions, though in the hundreds of meetings held by the important committees and those that have been active up to date in aiding the government by providing and distributing steel there have been, really, no star chamber discussions. Nothing has been done which is secret, and yet in securing all the information which has been furnished to the readers of class publications there has frequently been the greatest difficulty.

Sometimes the representatives of the class publications would have to stand around—I say this good naturedly—cooling their heels for hours before getting an interview sought in their desire to serve, in their wish to get the latest action or information to send to thousands and thousands of readers. I really believe that if the men who have charge of the various plants and those who have charge of giving out the information can realize the extent to which we are anxious to serve, they would sometimes find it easier to see representatives of the class publications than has been the rule in the past.

I believe that in this long drawn out struggle, the war in which we have been for a long time engaged, the iron and steel industry, and the American Iron and Steel Institute take a very important part in these services and as an aid to the government. I believe that the class publications only desire to serve by furnishing a greater measure of information to their readers than ever before, one simply carrying a message to help those interested and the government to win the war.

VICE-PRESIDENT KING: Mr. James R. Mills of Cleveland has also proposed a discussion of this paper. Because of illness in his family, he cannot be here to read his paper. But it will be put into the Year Book.

We are now to have a paper on The Effect of Phosphorus in Soft Acid and Basic Open Hearth Sticks by Dr. Unger of the Carnegie Steel Company. Dr. Unger has favored us several times in the past with valuable papers, and I am sure you will all be glad to hear him again. Dr. Unger's paper will be illustrated. Dr. Unger.

RELATION OF THE TRADE PAPERS TO THE IRON AND STEEL INDUSTRY

Discussed by JAMES R. MILLS

Manager of Sales, Carnegie Steel Co., Cleveland, Ohio

A college publication of the Middle West had in recent years for its motto this: "We aim not to mold public opinion, but to scrape the mold off of it." It can hardly be questioned that the iron and steel industry in times past has not given the heed that it should to uninformed and incorrect public opinion. Much of the time it has seemed that the industry was not sufficiently concerned to even attempt to keep off the mold. Yet, in its relations to the trade paper there has happily come a radical change for the better in recent years.

In former days, the trade paper in its efforts to get facts, was kept at arm's length, except by a few unscrupulous traders whose effort was to constantly play upon the credulity of the trade journal by reporting purely imaginary transactions for the purpose either of mystifying competitors or indirectly influencing market quotations. Some manufacturers did employ press agents, but these for the most part were so restricted in what they were allowed to tell that they pretty well fitted the nickname given them by newspapermen, of "suppress agents." This attitude did not indicate any particular unfriendliness to the trade journals; it was the period when secrecy was regarded as an absolute essential, both as to important operations and commercial transactions.

The era of candor and co-operation which has followed, and in which this Institute has played such an important part, has greatly changed the status of the trade journal. Suspicion of the trade journal has largely gone, along with suspicion of a competitor. With secrecy no longer considered a necessity, the task of a trade

journal is greatly simplified. For the trade papers themselves, it must be said that in the changing conditions of the last 20 years they have fought as privates in the ranks, making common cause of all that is vital to the industry.

Mr. Stephenson has shown how much of a necessity the trade journal has become, and how important is the information it gives us from week to week. In the broader field of informing public opinion the present times are giving new importance to the trade journal. In the notable work of Ivy L. Lee, in developing the public relations of the Pennsylvania railroad, Mr. Lee's aim was two-fold; first to interpret to the directors and officials of the Pennsylvania railroad the opinions and feelings of their employees and of the public, their patrons; second, to interpret to the public the aims and purposes of the Pennsylvania railroad.

Today there is scarcely an industry that is not vitally interested in what the steel trade is doing, and to a great many people this industry has become the commercial pathfinder. Interpreting to the public and to employees the aims and purposes of the iron and steel industry the trade journal fulfills one of its greatest services. It is the spokesman of the industry because no other agency has the background to fully comprehend the significance of what is occurring. The daily press, however willing, cannot do this. We heartily second Mr. Stephenson's plea that the trade paper be treated as a full-fledged ally entitled to our fullest confidence and co-operation.

EFFECT OF PHOSPHORUS IN SOFT ACID AND BASIC OPEN HEARTH STEELS

JOHN S. UNGER

Manager Central Research Bureau, Carnegie Steel Company, Pittsburgh, Pa.

This paper presents the results of an extensive investigation of the effects of phosphorus in soft acid and basic open hearth steels.

The steels were as nearly alike in chemical composition, with the exception of phosphorus, as was possible to secure in a practical way.

The effects of increasing amounts of phosphorus was studied particularly by fabricating the steel into finished articles requiring severe cold working in their production, as the commercial fitness or unfitness of this class of steel is not usually determined by physical tests but by the ability of the steel to be fabricated into a finished article and meet the requirements of ordinary service.

The results show an increased hardness due to increase in phosphorus, but do not show the steels to be brittle or cold short.

The purpose of this investigation was to compare soft acid and basic open hearth steels of varying phosphorus content, and of as nearly the same composition in other respects as it was possible to secure in a practical way, to determine what differences would be obtained by means of different mechanical tests, particularly by fabricating finished articles requiring severe cold working for their production.

GENERAL

Every metallurgist knows that phosphorus adds hardness to steel in the same manner that carbon or any other true hardening element does. Many persons believe that, in addition, it produces brittleness or what is called cold shortness.

Soft or low carbon steels are made up in the cold state into many articles requiring severe stamping, pressing, drawing, bending or upsetting operations. Articles of medium or high carbon steel requiring such operations are usually worked hot, giving very little opportunity to observe their properties until after they have become cold.

Soft steels for use in articles requiring severe cold working in their production are rarely tested by means of physical tests, the fitness or unfitness of the steel being determined by the ability to fabricate the steel and meet the requirements of ordinary service.

For this reason more attention was given to the fabrication of finished articles in this investigation, although physical tests of various kinds were made.

Large numbers of the several articles were made up cold in a practical way, the aim being to carry out the experiment in accordance with current conditions, being careful not to change the shop conditions or methods of operating at any particular plant. By making a considerable number of each article, a fair average result was obtained, which is considered to be truly representative of regular shop practice.

The steels were not given any special heat treatment, excepting such as is regularly given to ordinary soft steels, for instance, the annealing of sheets or the pickling and annealing of wire. The effects of heat treatment were not studied, as soft steels are rarely heat treated. A few tensile and other tests were made on some heat treated bars for information only.

COMPOSITION

Twelve ingots from the same heat of acid steel and fifteen from the same heat of basic open hearth steel, or eighty-four tons in all, were used in this experiment. The normal composition of each steel is given in Table I.

After the first three basic ingots had been poured, sufficient 17% powdered ferro-phosphorus was added

during the pouring of the next three ingots to increase the phosphorus to .030%. To the following three ingots the addition was increased to show a phosphorus content of .055%, the next three to .085% and the next three to .110% phosphorus. The same method was adopted in

COMPOSITION OF THE STEEL.

Table No. I.

<i>Kind of Steel</i>	<i>C.</i>	<i>Mn.</i>	<i>Phos.</i>	<i>S.</i>	<i>Si.</i>	<i>Cu.</i>
Acid Open Hearth.... (Ladle Analysis)	.12	.36	.032	.036	.020	.014
3 Ingots.....			.058			
3 Ingots.....			.085			
3 Ingots.....			.115			
Basic Open Hearth.... (Ladle Analysis)	.12	.36	.008	.037	.022	.012
3 Ingots.....			.030			
3 Ingots.....			.052			
3 Ingots.....			.080			
3 Ingots.....			.110			

the ingot additions to the acid steel, excepting that only three sets of three ingots each had additions of ferro-phosphorus made to them, as the original phosphorus in the steel was higher to begin with.

The ferro-phosphorus additions to the last set of ingots of each steel raised the phosphorus considerably above that regularly found in either acid or basic open hearth steel, but these additions were made to secure steels containing as much phosphorus as is ordinarily found in Bessemer steel. Any higher phosphorus content than that found in Bessemer steel was of no practical value; consequently, a study of steels containing higher percentages of phosphorus was not considered.

The method described furnished steels practically alike in every particular, except in the amount of phosphorus they contained; therefore, any differences found in the tests or finished products could be attributed to the phosphorus content.

All the phosphorus in the ferro-phosphorus was absorbed by the molten steel without appreciable loss. The amount of phosphorus found in the ingots and the

various steel articles checked the phosphorus additions very closely.

ROLLING.

The ingots were stripped and charged hot into the soaking pits, heated and rolled in the regular way into billets, slabs and sheet bar. A discard of about 25% was made from the top of each ingot to remove any pipe, sponginess or unsoundness. None of this material was chipped after rolling, and no difference was observed between the different ingots in the rolling mill. These semi-finished products were then shipped to the various mills to be rolled into sheets, wire rods and rounds, from which the finished articles were made.

PHYSICAL TESTS.

Longitudinal and transverse tensile, cold bending and drifting tests were made on the sheet bar, which was 0.467" thick. Tensile, vibratory and impact tests were made on the untreated and treated 1" rounds, and in addition, shearing tests were made on the same material, untreated. Longitudinal and transverse specimens from sheets .096" thick were tested by alternate bending, and specimens from sheets .048" thick were tested for their drawing qualities by the Erichsen Test. Tensile tests were made on both the wire rod and the wire.

The results of these tests are shown in Tables II to IX.

TENSILE TESTS ON SHEET BAR .467" THICK.

Table II. Longitudinal.

<i>Kind of Steel</i>		<i>Phos. Content</i>	<i>Elastic Limit</i>	<i>Ultimate Strength</i>	<i>Elongation in 8"</i>	<i>Reduction of Area</i>
			<i>Lbs. Per Sq. In.</i>	<i>Lbs. Per Sq. In.</i>	<i>%</i>	<i>%</i>
Acid	O. H.	.032	30,750	54,280	29.3	58.7
"	" " "	.058	31,215	57,290	32.0	58.7
"	" " "	.085	33,120	59,200	30.6	57.1
"	" " "	.115	35,665	62,070	29.4	47.0
Basic	O. H.	.008	29,130	50,780	34.3	61.0
"	" " "	.030	30,405	51,940	32.4	63.2
"	" " "	.052	30,675	54,350	32.4	62.6
"	" " "	.080	30,540	55,820	31.2	56.8
"	" " "	.110	32,550	58,635	31.2	55.9

Table III. Transverse.

Kind of Steel	Phos. Content	Elastic Limit	Ultimate Strength	Elongation Calculated	Reduction of Area	Actual Elongation
		Lbs. Per Sq. In.	Lbs. Per Sq. In.	to 8"	%	in 2"
Acid O. H..	.032	32,320	55,840	28.0	48.1	41.0%
" " "...	.058	32,550	59,410	24.0	43.9	35.0
" " "...	.085	31,840	59,530	29.0	41.1	43.0
" " "...	.115	35,770	63,700	24.0	46.4	35.0
Basic O. H..	.008	30,900	52,400	29.0	48.5	43.0
" " "...	.030	31,160	53,440	27.0	49.9	40.0
" " "...	.052	31,010	55,840	28.0	51.2	41.0
" " "...	.080	31,840	57,740	26.0	44.9	38.0
" " "...	.110	33,060	60,970	27.0	41.0	40.0

These tests were made in duplicate and the averages are shown in the tables. With the same phosphorus content, the acid steel shows approximately 3,000 pounds higher ultimate than the basic. On account of the width

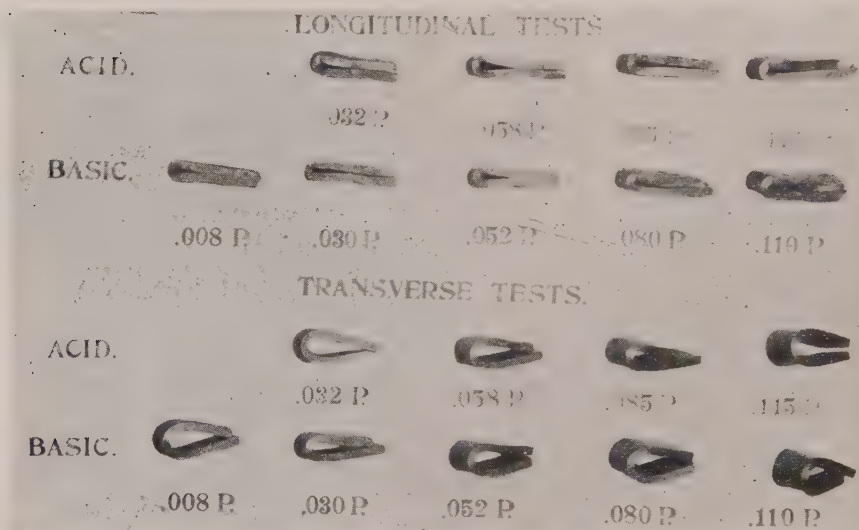


FIG. 1. Bend Tests (Specimen 8" x 2" x .467")

of the sheet bar, the transverse tests were pulled in 2" sections and calculated to 8" for comparison.

Longitudinal and transverse bends were made on the same material. All longitudinal bends closed up flat without showing any cracks on the outer surface. The transverse bends were closed until slight cracks could be seen, the bending then being stopped. The bent specimens are shown in Fig. 1.

DRIFT TESTS.

These tests were made on 18" pieces from the sheet bar, having three holes 15/16" diameter along the center of specimen, sufficient distance between holes and from the ends of piece to avoid disturbing the surrounding metal. The upper hole was punched away from the surface, the center hole was drilled and the lower hole was punched towards the surface. A drift 7/8" at the small end and 23/4" at the large end and 13" long was forced into each hole until cracks appeared at the edge of the hole on the under surface. The load required and the diameter of the hole after drifting are given in Table IV.

Table IV. Drift Tests.

<i>Kind of Steel</i>	<i>Phos. Content</i>	<i>Diam. Hole Punched AWAY FROM Surface</i>		<i>Load Req.</i>	<i>Diam. DRILLED Hole</i>		<i>Load Req.</i>	<i>Diam. Hole Punched TOWARDS Surface</i>		<i>Load Req.</i>
Acid O. H.	.032	1.26"		28,000	1.65"		35,200	1.46"		27,600
" " "	.058	1.23"		32,700	1.58"		31,000	1.39"		30,100
" " "	.085	1.26"		32,400	1.44"		30,800	1.35"		30,700
" " "	.115	1.22"		33,200	1.40"		34,100	1.42"		32,000
Basic O. H.	.008	1.30"		28,400	1.83"		32,200	1.45"		25,100
" " "	.030	1.26"		27,400	2.00"		35,900	1.58"		27,500
" " "	.052	1.28"		28,100	1.65"		31,800	1.50"		27,500
" " "	.080	1.32"		28,600	1.70"		33,500	1.47"		28,000
" " "	.110	1.30"		28,600	1.64"		34,300	1.35"		29,100

TENSILE TESTS ON 1" ROLLED ROUNDS.

Table V. Untreated

<i>Kind of Steel</i>	<i>Phos. Content</i>	<i>Elastic Limit Lbs. Per Sq. In.</i>		<i>Ultimate Strength Lbs. Per Sq. In.</i>		<i>Elongation in 8"</i>	<i>Reduction of Area</i>
						<i>%</i>	<i>%</i>
Acid O. H.	.032	39,910		55,450		26.8	66.5
" " "	.058	40,130		56,880		25.0	64.2
" " "	.085	41,540		59,640		26.2	64.0
" " "	.115	42,900		60,640		26.0	65.9
Basic O. H.	.008	34,410		49,350		28.7	71.6
" " "	.030	37,350		51,380		29.0	70.9
" " "	.052	38,060		52,240		28.3	70.3
" " "	.080	40,530		55,840		27.5	70.3
" " "	.110	40,180		57,000		23.7	60.2

Table VI. Treated.*

<i>Kind of Steel</i>	<i>Phos. Content</i>	<i>Elastic Limit</i>	<i>Ultimate Strength</i>	<i>Elongation in 8"</i>	<i>Reduction of Area</i>
		<i>Lbs. Per Sq. In.</i>	<i>Lbs. Per Sq. In.</i>	<i>%</i>	<i>%</i>
Acid O. H....	.032	47,490	64,280	21.2	71.6
" " "....	.053	49,380	65,520	21.8	67.5
" " "....	.085	51,800	67,720	21.7	68.7
" " "....	.115	51,840	68,700	19.3	67.5
Basic O. H....	.008	42,780	54,100	28.1	80.6
" " "....	.030	45,580	57,260	28.5	78.4
" " "....	.052	46,380	59,340	26.2	74.5
" " "....	.080	46,500	60,020	27.8	75.1
" " "....	.110	46,840	61,860	25.0	65.0

* The treatment consisted in quenching in water at 880 degrees centigrade and drawing back at 600 degrees centigrade.

VIBRATORY AND IMPACT TESTS.

The vibratory tests were made on specimens $\frac{3}{8}$ " in diameter by 6" long. The specimens were gripped 4" from one end and vibrated $\frac{3}{8}$ " in each direction at 650 vibrations per minute until failure occurred. The specimens were long enough to make a test at each end.

In the impact tests, a standard S. A. E. specimen, 10 mm. square, notched 2 mm. deep and 1 mm. wide, was tested with a 200 foot-pound pendulum machine, without being able to break the specimen, as they were so tough they would bend over and wedge under the tup. Repeated trials by cutting the notch 5 mm. deep did not improve matters. The notch was finally cut $6\frac{1}{2}$ mm. deep and turned away from the tup, when a clean break was obtained.

The writer's previous experience with both vibratory and impact tests has led him to place little confidence in either test, and the present tests have not proven an exception.

These tests, particularly the impact tests, were made to try to show that the higher phosphorus steels were brittle under a dynamic or shock test. Nothing seems to be indicated by the conflicting results and nothing is claimed for them, excepting that they have not shown any greater brittleness on the high phosphorus than on the lower phosphorus steels. They are inserted as a

matter of interest only. The vibratory tests are the average of four tests, the impact the average of two tests.

The results of the vibratory and impact tests are shown in Table VII.

Table VII.

RESULTS OF VIBRATORY AND IMPACT TESTS.

<i>Kind of Steel</i>	<i>Phos. Content</i>	<i>No. of Vibrations</i>		<i>Impact Foot Pounds</i>	
		<i>Untreated</i>	<i>Treated</i>	<i>Untreated</i>	<i>Treated</i>
Acid O. H....	.032	1,236	1,355	34.2	48.6
" " "....	.058	1,415	1,236	41.4	50.4
" " "....	.085	1,213	1,044	34.2	41.4
" " "....	.115	1,041	1,244	46.8	37.8
Basic O. H....	.008	1,491	1,255	32.4	41.4
" " "....	.030	1,477	1,314	39.6	41.4
" " "....	.052	1,422	1,302	48.6	55.8
" " "....	.080	1,451	1,369	46.8	50.4
" " "....	.110	1,305	1,331	48.6	54.0

The treated steel was quenched at 880 degrees centigrade in water and drawn back at 600 degrees centigrade.

SHEARING TESTS AND RIVETED JOINT TESTS.

The shear tests were made on specimens $\frac{3}{4}$ " in diameter, subjected to double shear in a shearing block, using a shearing blade 1" thick. Riveted joints were prepared by riveting up a joint of two bars 5" wide, $1\frac{1}{4}$ " thick with 2-1" hot driven rivets, spaced 2" from centers of rivets and $1\frac{1}{2}$ " from ends of bars. The riveted joints, after breaking, are shown in Figs. 2 and 3.

The results of these tests are given in Table VIII.

Table VIII.

RESULTS OF SHEARING TESTS AND RIVETED JOINT TESTS.

<i>Kind of Steel</i>	<i>Phos. Content</i>	<i>Load to Double Shear $\frac{3}{4}$" Diam. Rounds</i>	<i>Strength of Hot Riveted Joint, Two 1" Diam. Rivets</i>
		<i>lbs.</i>	<i>lbs.</i>
Acid O. H....	.032	36,985	79,100
" " "....	.058	38,830	82,400
" " "....	.085	40,165	88,200
" " "....	.115	40,080	86,700
Basic O. H....	.008	34,845	74,700
" " "....	.030	36,180	76,200
" " "....	.052	36,475	78,300
" " "....	.080	36,340	81,900
" " "....	.110	36,220	79,800

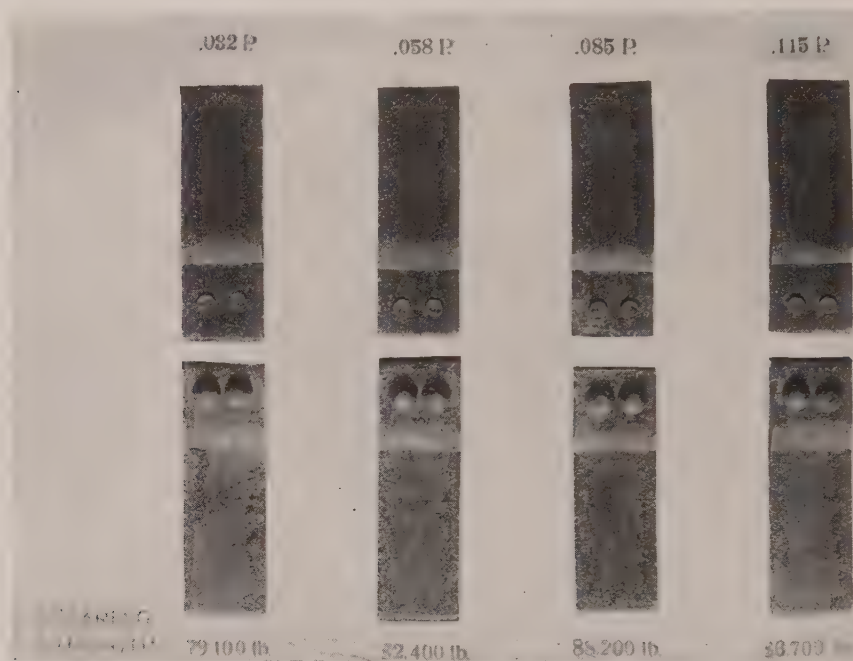


FIG. 2. Shearing Test of One-inch Acid Open Hearth Riveted Joints

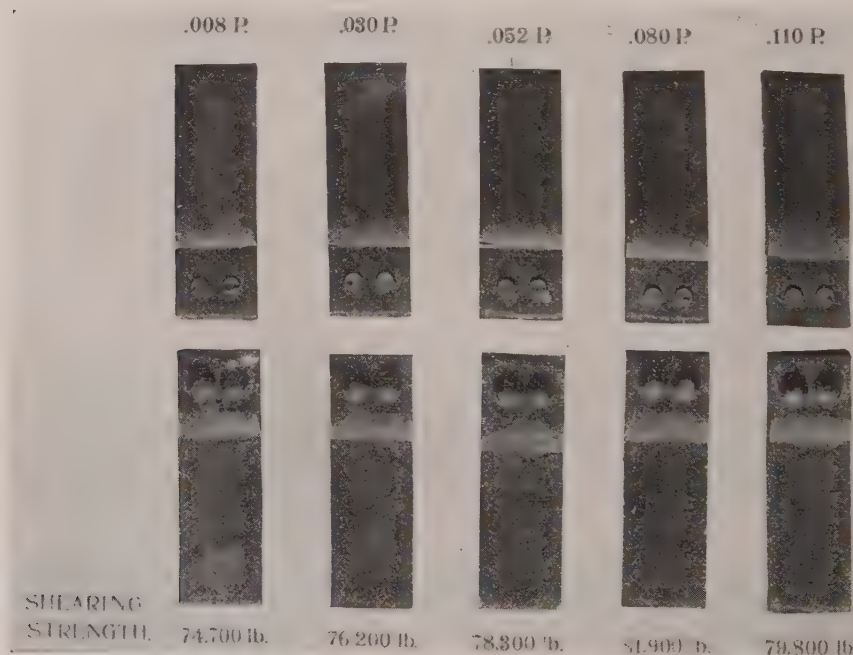


FIG. 3. Shearing Test of One-inch Basic Open Hearth Riveted Joints

TESTS ON THE RIVETS.

Several rivets 12" long from each grade of steel were cold flattened to $\frac{1}{4}$ " thick, as shown in Fig. 4, no cracks developing on the flattened edges. Additional rivets were gripped under the head in a strong clamp and

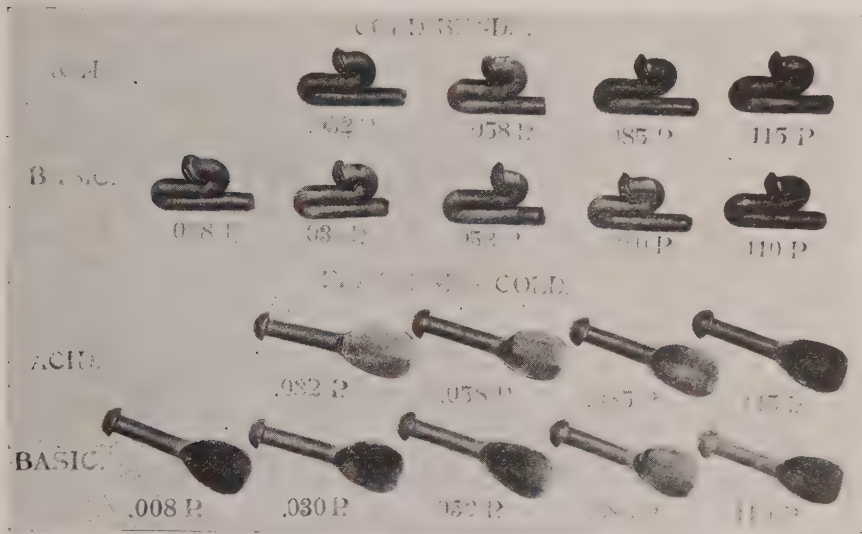


FIG. 4. Cold Bends and Flattening Tests—One-inch Rivets

bent into a rough shape like the letter "S," afterwards being closed up tight under the steam hammer, to try to snap the head off or break the rivet by bending under cold impact. No cracks developed on bending. Fig. 4 shows the rivets after testing.

BENDING AND ERICHSEN TESTS ON SHEETS.

Longitudinal and transverse tests 1" wide were cut from sheets .096" thick and given a bending test by gripping vertically in a vise and attaching a clamp to the part projecting above the vise jaws, fastening the clamp the thickness of sheet above the jaws; then bending back and forth through an angle of 90 degrees from both sides of the vertical until broken. Each motion through 90 degrees is counted as one bend.

Duplicate specimens were tested as rolled and after normalizing at 900 degrees Centigrade for five minutes.

Drawing tests were made in duplicate on the Erichsen machine on sheets .048" thick. The results are shown in Table IX.

Table IX.

RESULTS OF BENDING AND DRAWING TESTS.

		Bending Tests, Sheets .096" Thick. No. Bends.				Erichsen Test, Sheets .048", Thick, Depth
Kind of Steel	Phos. Content	As Rolled		Normalized at 900°C.		of Cup
		Long.	Trans.	Long.	Trans.	
Acid O. H.	.032	3	3	4	4	9.22mm
" " "	.058	4	3	5	4	9.08
" " "	.085	3	3	4	4	9.04
" " "	.115	3	2	4	3	8.71
Basic O. H.	.008	4	4	4	4	9.77
" " "	.030	4	3	4	4	9.65
" " "	.052	3	3	4	4	9.35
" " "	.080	3	3	4	3	9.13
" " "	.110	4	3	5	4	9.23

THREADING TESTS.

To determine what differences might exist in the finish and power required in machining, threading tests were made in duplicate on bars 1.016" in diameter, in the As Rolled condition and after heating to 900 degrees Centigrade and quenching in cold water. A die cutting 14 threads per inch was equipped with a lever to which a dynamometer was attached, to measure the pull in pounds while cutting the threads. The results are shown in Table X.

Table X.

RESULTS OF THREADING TESTS.

Kind of Steel	Phos. Content	As Rolled	Power Required
			Quenched from 900 deg. C., in Cold Water
Acid O. H.	.032	22.0 lbs.	37.0 lbs.
" " "	.058	23.7 "	35.5 "
" " "	.085	25.3 "	38.0 "
" " "	.115	23.5 "	35.5 "
Basic O. H.	.008	23.0 "	41.5 "
" " "	.030	22.7 "	35.5 "
" " "	.052	23.3 "	36.0 "
" " "	.080	26.0 "	45.5 "
" " "	.110	20.7 "	39.5 "

COLD DRAWN SHAFTING.

Duplicate rolled rounds 30 feet long and 1.016" diameter were pickled at one time in the same acid in solution, and then drawn into rounds .933" in diameter. The noticeable thing was the greater action of the pickling acid as the phosphorus increased. This is shown in the gradually decreasing diameters and the condition of the surface of the bars before drawing. This was pronounced enough to enable one to tell the phosphorus content by the diameter of the bar after pickling. After drawing, straightening and inspection, every experimental bar was commercially perfect and was applied on current orders. The results are given in Table XI.

Table XI.
RESULTS OF COLD DRAWING EXPERIMENT.

<i>Kind of Steel</i>				<i>Diameter of Bar BEFORE Pickling</i>	<i>Diameter of Bar AFTER Pickling</i>	<i>Condition of Surface After Pickling</i>	<i>Diameter of Bar After Drawing</i>
<i>Phos. Content</i>							
Acid	O.	H....	.032	1.016"	1.011"	Smooth	.933"
"	"	"....	.058	"	1.007"	Smooth	"
"	"	"....	.085	"	1.006"	Rough	"
"	"	"....	.115	"	1.003"	Rough-Seamy	"
Basic	O.	H....	.008	"	1.013"	Smooth	"
"	"	"....	.030	"	1.011"	Smooth	"
"	"	"....	.052	"	1.009"	Moderately Smooth	"
"	"	"....	.080	"	1.006"	Rough	"
"	"	"....	.110	"	1.002"	Rough-Seamy	"

WIRE PRODUCTS.

Three 4"x4" billets of each grade were rolled into wire rod, then drawn into wire of various sizes and used to make 1" ten jaw barbed roofing nails with 7/16" heads; button-head rivets, length 1", diameter of shank 3/8", diameter of head 5/8"; flat-head rivets, length 5/8", diameter of shank 3/8", diameter of head 7/8" and thickness of head .145". In drawing the wire, it was found that the steel was harder to draw and more breaks occurred in drawing as the phosphorus content increased.

In making the roofing nails, it was necessary to re-

TESTS AND MILL PRACTICE ON WIRE PRODUCTS.

Table XII.

Kind of Steel	Phos. Content	Wire Rod Diameter Ult. Str. Lbs. Sq. In.	Elongation Wire Rod in 10" %	Wire Diameter Ult. Str. Lbs. Sq. In.	Elongation Wire in 10" %	Button-Head		Flat-Head	
						Rivets %	Good Heads	Rivets %	Good Heads
Acid O. H.	.032	51,500	21.2	82,000	Broke in Jaws	41.2	6.2		
" "	.058	56,500	24.2	83,500	3.8	90.0	0		
" "	.085	59,900	23.8	81,000	3.5	14.8	0		
" "	.115	63,500	23.7	89,900	Broke in Jaws	15.4	0		
Basic O. H.	.008	48,800	26.7	75,600	Broke in Jaws	100.0	88.6		
" "	.030	50,900	25.0	78,600	4.8	100.0	21.8		
" "	.052	54,300	23.8	80,000	5.0	85.7	2.0		
" "	.080	54,700	25.0	83,200	4.7	40.7	3.7		
" "	.110	58,700	27.2	85,500	4.9	96.6	0		
Reg. Dead soft Open Hearth .06C.		39,250	27.5	71,000	6.5	100.0	13.9		

grind the hammers more frequently than on regular dead-soft open hearth stock, as the wire was harder to head up. Outside of this trouble, all grades were made up into perfect roofing nails. In heading the button-head rivets the results were erratic, due probably to some small difference in the operation. It can be said, in a general way only, that the harder the steel the greater the difficulty in heading the rivet. The flat-head rivet was a very severe upsetting operation. It may be called a dynamic upsetting test, and unless the steel is very soft, it will not produce a head free from cracks at the edges.

The tests on the wire rod and the mill practice on the button-head and flat-head rivets are given in Table XII and in Fig. 5. For purposes of comparison, a dead-soft basic open hearth regular steel of about .06% carbon was carried along with the experimental steels.

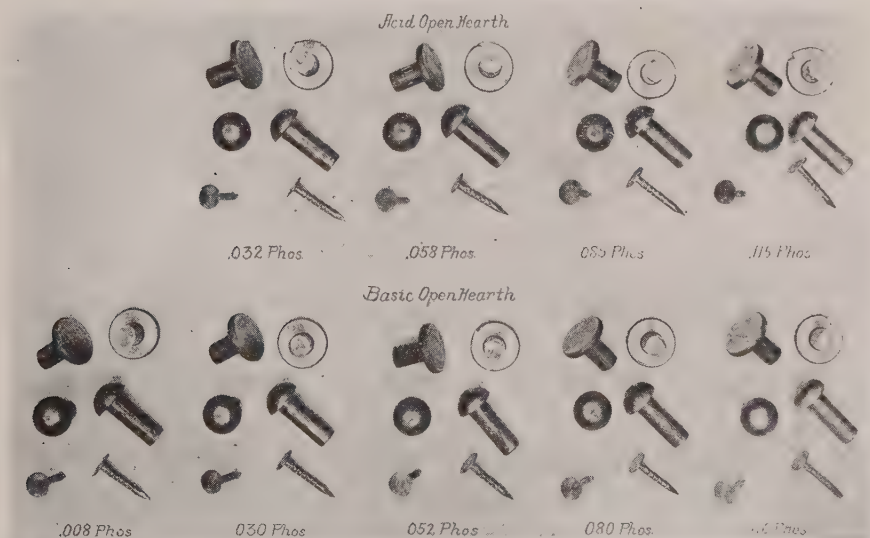


FIG. 5. Wire Products, Rivets, Roofing Nails, etc.

STUDENT LAMP CUPS AND AUTOMOBILE HUB CUPS.

Steel of each grade was made into cold rolled strip steel and then stamped into cups for student lamps and automobile hub cups.

No difficulty was experienced with any of this steel, all of it being made into perfect lamp cups or automobile hub caps, and no differences could be observed in the

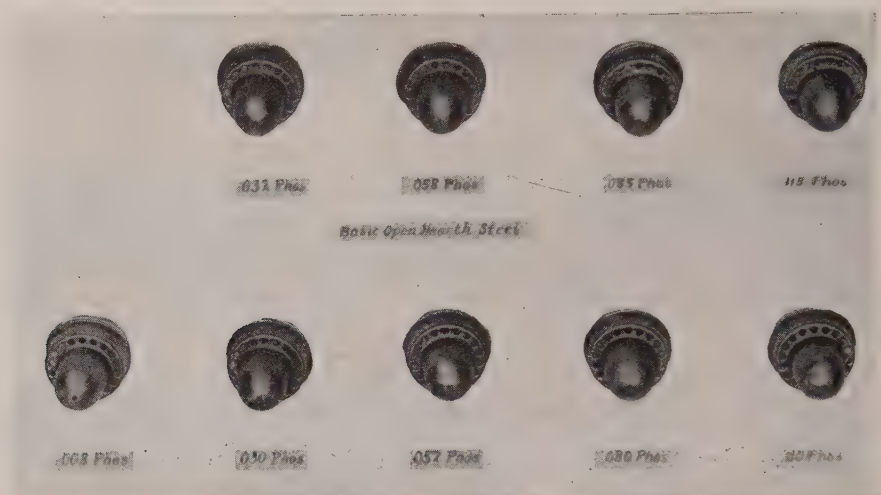


FIG. 6. Caps for Student Lamps

finished articles, regardless of phosphorus content. The student lamp cups are shown in Fig. 6.

STEEL BARRELS.

Slabs of each grade of steel were rolled into sheets .130" thick, sheared into disks 57½" in diameter and fabricated into 55-gallon gasoline or oil barrels.

The process of manufacture into barrels consisted of four straight drawing operations with intermediate annealing and pickling; followed by three final operations, consisting of bilging, forming the chine and curling the edge.

A total of 215 disks were used, of which eight had to be scrapped, six of which were due to defective sheets,

one to mechanical operation and one due to crack developing during drawing; making a total of 207 barrels, which were tested with air for leaks, and accepted. Fig. 7 shows a sample disk and one barrel of each grade of steel and Table XIII gives the number of each kind and the practice on the same.

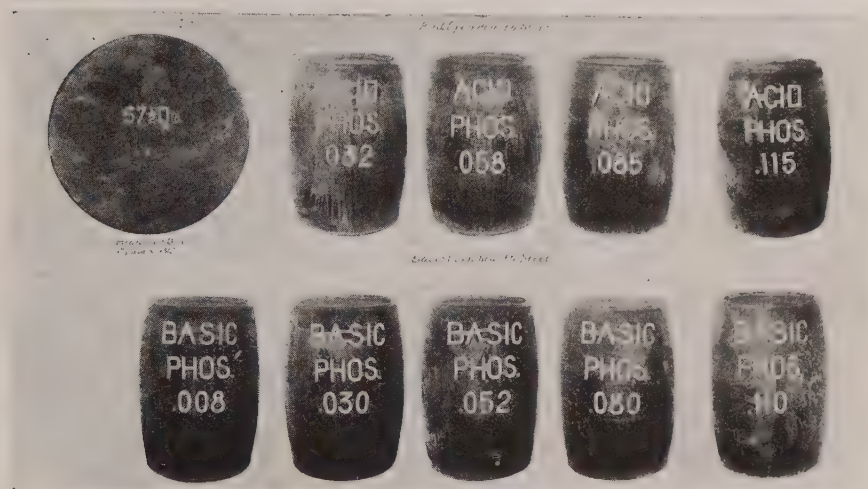


FIG. 7. 55-gallon Steel Barrels

RESULTS WITH STEEL BARRELS.

Table XIII.

Kind of Steel		Phos. Content	Number Pieces Tested	Number Good Barrels	Percent Good Barrels
Acid	O. H.	.032	24	23	96
"	" "	.058	24	24	100
"	" "	.085	24	24	100
"	" "	.115	24	23	96
Basic	O. H.	.008	24	22	92
"	" "	.030	23	23	100
"	" "	.052	24	22	92
"	" "	.080	24	24	100
"	" "	.110	24	22	92

AUTOMOBILE RUNNING BOARD SHIELDS.

Sheet bars of each grade of steel were rolled into sheets $18\frac{1}{8}$ "x65"x22 gauge (.03125"), and the sheets made into running board shields.

No trouble was experienced in the manufacture of

the shields from any grade of steel, and the total number of 285 pieces, or approximately 32 pieces of each grade, were made into finished shields and used with the regular material in the manufacture of cars.

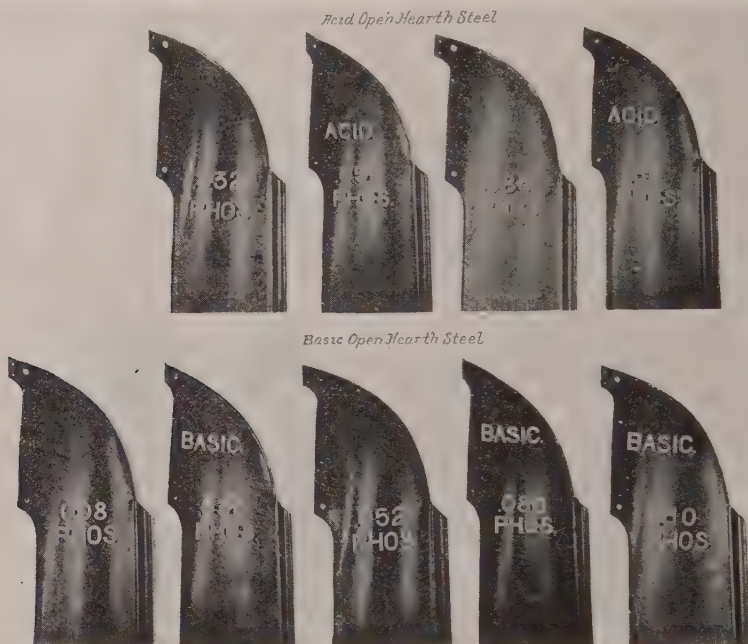


FIG. 8. Automobile Running Board Shields

In fabricating these shields, most of the trouble is experienced in turning over the edge along the curved portion at the top of the shield, but none of the experimental steel cracked, and an examination of Fig. 8 shows no difference in the appearance of steels of any phosphorus content.

AUTOMOBILE COWLS.

Sheets 35"x84"x20 gauge (.0375") were used for fabricating into automobile cowls or shrouds, 17 pieces of each grade of steel being used, or a total of 153 sheets, all of which were made into cowls and used in the manufacture of cars in accordance with the usual shop prac-

tice; with the exception of one cowl of low phosphorus basic open hearth steel, which had to be scrapped on account of the sheet being defective. Fig. 9 shows the appearance of cowls of each grade.

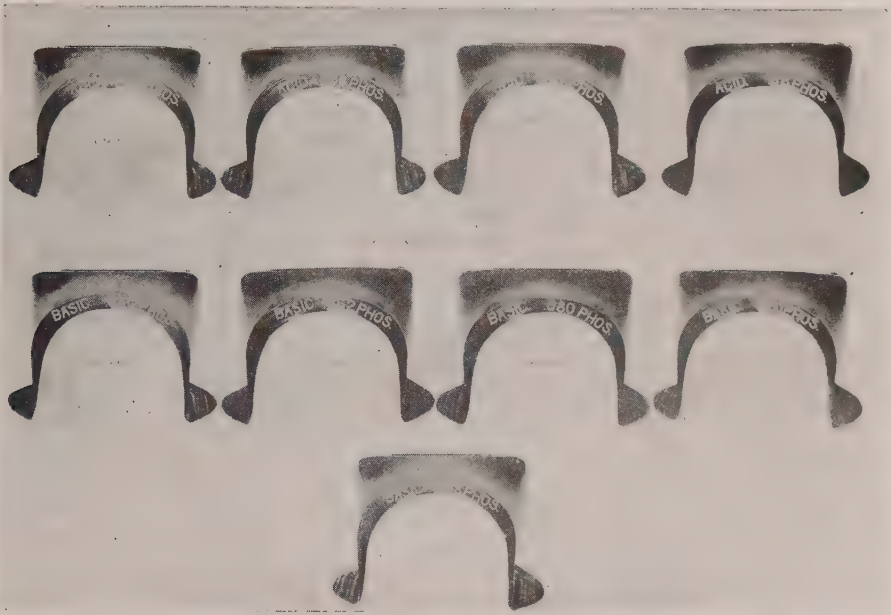


FIG. 9. Automobile Cowls

AUTOMOBILE RADIATOR CASINGS.

Radiator casings were made from sheets 32"x35"x20 gauge (.0375") of each grade of steel, a total of 293 sheets, or approximately 32 sheets of each grade being used.

The results obtained were erratic. The draw in this operation is made very quickly and most of this steel seemed to be too stiff for the purpose, although the softest steel of the lot, or the .008 phosphorus basic, gave much worse results than a number of the other grades. Fig. 10 shows a characteristic radiator casing of each grade of steel, and Table XIV shows the number of pieces of each grade tested, the number of casings used in the manufacture of automobiles and the percentage or shop practice obtained.

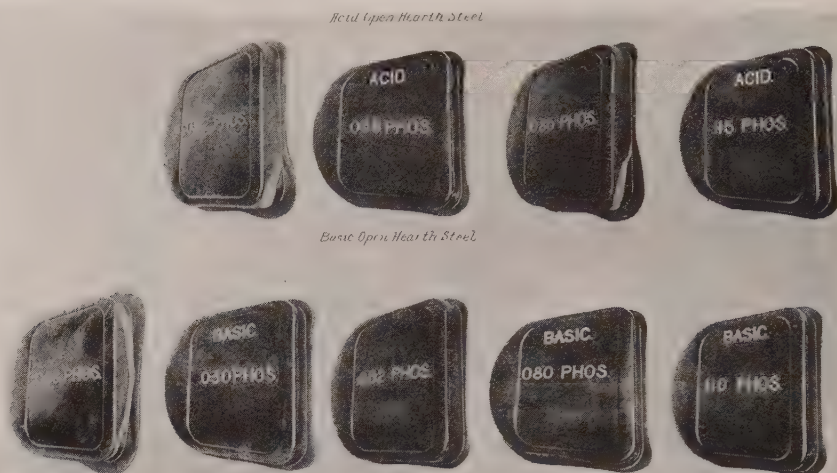


FIG. 10. Automobile Radiator Casings

RESULTS WITH AUTOMOBILE RADIATOR CASINGS.

Table XIV.

Kind of Steel		Phos. Content	Number Pieces Tested	Number Casings Used	Number Casings Scrapped	Percentage Casings Used
Acid	O. H.	.032	35	5	30	14
"	" "	.058	32	20	12	63
"	" "	.085	35	1	34	3
"	" "	.115	35	0	35	0
Basic	O. H.	.008	29	5	24	16
"	" "	.030	32	20	12	63
"	" "	.052	31	27	4	87
"	" "	.080	32	16	16	50
"	" "	.110	32	3	29	9

AUTOMOBILE CORNER PANELS.

Two sizes of corner panels were made of each grade of steel. For the large size, sheets 35"x84"x20 gauge (.0375") were used; and for the smaller size, sheets 34"x48"x20 gauge.

This operation is very severe, and while the results were to some extent erratic, the stiffer or harder steels, as a whole, gave poorer results than the steels with lower tensile strength, or in other words, the higher phosphorus steels were too hard for the purpose.

Fig. 11 shows characteristic corner panels of each grade.



Fig. 11. Automobile Corner Panels

Table XV shows the number of sheets of each grade tested for both the large and small corner panels, the number of panels of each kind used in the manufacture of cars and the percentage of panels used, or the shop practice.

RESULTS WITH AUTOMOBILE CORNER PANELS.

Table XV.

Kind of Steel	Phos. Content	Large Corner Panels			Small Corner Panels		
		Number Pieces Tested	Panels Used in Autos	Percent Panels Used	Number Pieces Tested	Panels Used in Autos	Percent Panels Used
Acid O. H	.032	17	8	47	35	20	57
" " "	.058	18	5	28	35	28	80
" " "	.085	16	0	0	35	19	54
" " "	.115	18	1	6	35	6	17
Basic O. H	.008	17	17	100	32	32	100
" " "	.030	18	18	100	34	33	97
" " "	.052	18	15	83	31	30	97
" " "	.080	18	8	44	32	22	69
" " "	.110	18	15	83	32	25	78

CREAM SEPARATOR BOWLS.

Sheets of each grade, 18 gauge (.050"), were made into cream separator bowls.

The process of manufacture consisted of four drawing operations, followed by an annealing and a fifth drawing operation; after which the bowl was hydraulically expanded to shape, edges curled, opening punched for outlet drain, bowls cleaned, pickled and then thinned. The finished bowl is 8" deep, $14\frac{1}{8}$ " in diameter at the belly, and $12\frac{3}{8}$ " in diameter at the neck.

The first drawing operation is particularly severe, owing to the size and shape of depression for the outlet drain. Unless the steel is very soft and ductile, it will tear at the deep end of this depression and cause the rejection of the bowl. The higher phosphorus steels were too hard and stiff for this operation, and a number of them failed, particularly the .085 and .115% phosphorus acid steels.

A total of 315 sheets were used, or 35 of each grade, and a total of 194 perfect bowls were made and used in the manufacture of cream separators. Table XVI shows the number of each grade tested, failures on drawing and expanding operations and the number of perfect bowls.

RESULTS WITH CREAM SEPARATOR BOWLS.

Table XVI.

	Kind of Steel	Phos. Content	Number Pieces Tested	Failures		Number Bowls Used	Percent- age Bowls Used
				on Drawing Operation	on Expanding Operation		
Acid	O. H. . .	.032	35	8	0	27	77
"	" " " . . .	.058	35	14	0	21	60
"	" " " . . .	.085	35	35	..	0	0
"	" " " . . .	.115	35	29	3	3	9
Basic	O. H. . .	.008	35	3	0	32	91
"	" " " . . .	.030	35	3	0	32	91
"	" " " . . .	.052	35	3	0	32	91
"	" " " . . .	.080	35	10	2	23	66
"	" " " . . .	.110	35	8	3	24	69

CONCLUSION.

The results of this investigation speak for themselves. None of the steels showed brittleness under cold working due to the phosphorus. An examination of the results of the various mechanical tests, cold bending of the rivets under a hammer, the severe upsetting in making large headed nails or rivets, or the fabrication of barrels, automobile parts and cream separator bowls, indicate nothing more than an increased hardness due to increase in phosphorus. This condition remains the same regardless of whether the force was applied slowly or statically, or if applied by shock or blow.

The results show that in soft steels an increase in phosphorus of .01% is equivalent to an increase in tensile strength of about 850 pounds per square inch, which is practically the same as would be obtained by increasing the carbon .01%. Hence, higher phosphorus, soft or low carbon steels can be used for various purposes, provided the carbon content is decreased sufficiently to compensate for the increased hardness due to the phosphorus.

In conclusion, I wish to express my thanks to the various steel works and other manufacturers who assisted in carrying out this investigation.

VICE-PRESIDENT KING: Dr. Unger's paper will be discussed by Mr. Bradley Stoughton. But Mr. Stoughton has not had opportunity to prepare his discussion in time for this meeting, so it will be inserted in the record without being read at this time.

EFFECT OF PHOSPHORUS IN SOFT ACID AND BASIC OPEN HEARTH STEELS

Discussion by BRADLEY STOUGHTON

Secretary, American Institute of Mining Engineers, New York

While the research of Dr. Unger is probably the most comprehensive that has ever been undertaken upon the effect of phosphorus on soft steel, the facts which he brings out have been recognized for a very long time by metallurgists without in any sense lessening the apprehension felt as to the presence of phosphorus in steel of any degree of hardness. In the Proceedings of the Institution of Civil Engineers for the years 1874 to 1875, Vol. XLII, W. Hackney, on page 37, says: "The proportion of phosphorus that steel may contain, without becoming brittle, depends on its percentage of carbon, and probably also of silicon. The best steel, that which combines with a given degree of hardness and tensile strength the greatest toughness, and the greatest extensibility before fracture, contains not more than 0.01 or 0.02 per cent. of phosphorus; but at the same time steel containing very much more phosphorus than this may be tough enough and strong enough for ordinary purposes, if the percentage of carbon is diminished in proportion as the amount of phosphorus becomes greater. Tool steel containing from 0.7 to 1 per cent. of carbon becomes sensibly brittle when the phosphorus exceeds 0.03 or 0.04 per cent.; and though steel for rails, if nearly free from phosphorus, and at the same time containing little silicon, is not made too hard to be safe by even 0.6 or 0.7 per cent. of carbon, yet if the phosphorus amounts to 0.05 or 0.06 per cent., the carbon cannot be prudently allowed to exceed 0.45 per cent.; and steel rails containing 0.1 per cent. of phosphorus should never contain more than 0.3 per cent. of carbon; and so on, until when the carbon is kept down to 0.16 per cent.,

steel containing 0.3 per cent. of phosphorus will yet make serviceable rails, and that containing 0.15 per cent. will make excellent tough boiler-plates, that may be bent double, cold, after heating to redness and quenching in water; while, of course, metal free, or nearly free, from phosphorus is still softer and tougher, more, in fact, like copper than like any commonly-known variety of iron."

Continuing the discussion, the same author indicates that even forty years ago this knowledge was not new.

The apparent harmlessness of phosphorus in soft steel was used by advocates of the Clapp and Griffiths process in the early eighties in an attempt to exploit the process with the claim that its product was less susceptible to the embrittling effect of phosphorus than was the product of other converters. In Volume XIII of the Transactions of the American Institute of Mining Engineers the question was very thoroughly thrashed out, and again was demonstrated the acquaintance of engineers with the relative harmlessness of phosphorus in the absence of carbon and silicon. If, therefore, engineers who for fifty years have been acquainted with these facts are still unwilling to approve of phosphorus as a means for strengthening and hardening steel we do not believe that even the admirable research of Dr. Unger will change the opinion or practice.

VICE-PRESIDENT KING: I have often said that a little excess of phosphorus did not hurt the steel any, and now I am glad to have that confirmed by Dr. Unger.

We are not to hear the last paper on the list. Mr. Blauvelt could not come, but I believe he has sent his paper, owing to lack of time to prepare the room for the banquet it will not be read, but will be published along with the others.

Now, I believe Mr. McCleary has some announcements to make.

MR. MCCLEARY: Mr. Blauvelt's paper will be published in the Year Book, as Mr. King has told you, with a dis-

cussion by Mr. Forbes of the United States Steel Corporation. The paper on trade papers will be discussed also by James R. Mills, who expected to be here, but he was detained by sickness.

One of the things that struck me as I watched the "movies" that Mr. Robinson gave us today, was this: That when we see the finished product of anything it is hard to realize how much skill and pains and effort and time it has taken to produce that finished product. Just so with the dinner tonight. We are going to have a crowd such as we never had before, and we did not know until yesterday and today that such a crowd was going to be here. I am not apologizing. The man who excuses himself accuses himself. I am simply explaining on account of this war, we thought at first we'd do well if we had this floor half filled. Tonight we are going to fill not only this floor, but both balconies full of diners, and it is some job to take care of such a crowd.

Now, gentlemen, if you find that you have not been as well taken care of as you feel you should, ask yourselves: Did I give the Institute a fair show? Did I tell the Institute in time that I was going to come? If you did, just please remember that we are human and we are liable to make mistakes, and as you were told this morning the Government has necessarily been asking more and more of us all the time, and I know that you will be considerate. Now, there isn't one of you that we would not gladly serve to the extent of our ability, and if you are not served so well tonight, well, we will try to serve you better next time. (Applause.)

(The meeting then adjourned to 7 p. m.)

OUR BY-PRODUCT COKE OVEN INDUSTRY IN THE WAR.

By WILLIAM HUTTON BLAUVELT,

Consulting Engineer, Semet-Solvay Co., Syracuse, N. Y.

For many years European economists have felt that it was a reproach to the United States that it should cling so long to the beehive oven for the manufacture of coke, deliberately throw away annually millions of dollars' worth of the many valuable by-products obtainable from the distillation of coal. Most fortunately for us in this great crisis through which we are now passing, this reproach is being rapidly removed. Forty per cent. of the coke made in 1917, or 22,600,000 tons, was by-product coke, and some time this year, as the new plants come into run, the production of by-product coke will pass the beehive output. Ovens with a capacity of 13,500,000 tons of coke are in process of construction, and half as much more is contemplated. What did this great and rapidly growing industry mean to us as we entered the war a year ago and began our preparations for taking our place as active combatants in this greatest of all struggles?

From the side of fuel conservation, which last winter's experience showed us to be of the most vital importance, the by-product ovens now in run have a capacity for producing 5,000,000 more tons of coke per annum than if the same coal had been coked in beehive ovens. Moreover, they have made possible the utilization for coking purposes of many deposits of coal that otherwise would not have been available.

Assuming all the plants were in full run, they would

produce 315,000,000 gal. of tar, which may be used for fuel, having the same efficiency as fuel oil, to say nothing of its other important uses in the arts. Assuming an average production of 4,000 ft. of surplus gas per ton of coal, including ovens of the older and newer types, the average annual production is 168,000,000,000 ft. of gas, which would melt 13,000,000 tons of steel in the open-hearth furnace.

MATERIALS FOR EXPLOSIVES.

But it is in furnishing raw materials for high explosives that the by-product oven industry is most vitally essential to our prosecution of the war. Entirely aside from the economic importance of the conservation of our nation's resources, which is so vital at this time, if this industry had not been developed we should have had to depend entirely upon the Allies for almost every pound of high explosives, without a plentiful supply of which this highly scientific warfare could not have been carried on by us for a single day, and, as we know, the Allies have had to utilize every resource to obtain sufficient raw materials for producing their own explosives. Practically all the high explosive shells used at the battle front are loaded with picric acid, T.N.T. and ammonia powders. Picric acid is tri-nitro-phenol, which is produced by nitrating phenol or carbolic acid. Carbolic acid has been produced for many years from the distillation of coal tar, but under present conditions in this country very much the larger production of carbolic acid is obtained by the synthetic process by the sulphonation and nitration of benzol. T.N.T., or tri-nitro-toluol, is produced from the direct nitration of toluol, and the ammonia powders have, of course, ammonia as their base. With the exception of a relatively small production from gas works, all our supply of these products is obtained from the distillation of coal in the by-product oven. The ovens now in run have a capacity for carbonizing 42,000,000 tons of coal per

year, and those building or planned will add 70 per cent. to this amount. The present tonnage means an output of approximately 63,000,000 gal. of chemically pure benzol, 14,000,000 gal. of toluol and 100,000 tons of ammonia. I need only call your attention to these figures to demonstrate to you the importance of the by-product industry to our war requirements. It is not pleasing to contemplate what would have been our position if the large development of the by-product oven had been delayed only a few years.

BASIS OF MANY INDUSTRIES.

This industry has done much more for America than the conservation of our fuel resources and furnishing a supply of raw materials for our high explosive shells. It has taken an important part in the development on a sound basis of a wide line of chemical industries, in which our country was so far behind others until quite recent years. American manufacturers have had the money and will, and American chemists have had the brains and the knowledge; but until the products of coal distillation were available as raw materials, we made little progress in some of the great branches of chemical manufacturing, which had been so highly developed in European countries. The great color and dye industry is a notable illustration of this fact. While this industry itself is represented by relatively small values, some of the most important industries in the country are vitally dependent upon it. We learn from Government reports that there are over 14,000 establishments in our country which are absolutely dependent upon dyes and colors. These establishments employ over \$3,000,000,000 capital and it is estimated that over 2,000,000 working men and women are occupied in manufacturing plants which are directly dependent upon the use of artificial dyes and colors, and nearly all of these depend in whole or in part on the products of the distillation of coal for their raw materials. Natur-

ally the color makers turned first to the colors which are consumed in the largest quantities, such as blacks and blues, but the list is being rapidly extended to cover the full line of dyes and colors used by the American trade. Printing inks, both black and colored, depend on the prussiates for their raw material, but it is doubtful whether it is realized in many of the thousands of printing offices in the country that the by-product oven is the basis of their supplies of ink.

KEYSTONE PRODUCTS.

From the point of view of the chemical industries, many of the products of the distillation of coal are what are termed Keystone products. That is, while they are relatively unimportant in themselves, they are essential to other greater industries, and still others owe their development to the needs created by these Keystone industries. For example, aniline, which is made from benzol, and which is the base of a long list of colors, is also the raw material for indigo. In the production of indigo, it is necessary to have available a supply of the strongest sulphuric acid, which is entirely beyond the possibility of the old and well-known chamber process. The contact process for producing these strong sulphuric acids was developed to meet this need, utilizing oxygen obtained from the air for the oxidation of the sulphur gases. With this process was developed the fixation of atmospheric nitrogen and the oxidation of ammonia for the production of nitric acid, thereby obtaining independence of the Chilian supplies of sodium nitrate. All of these processes have demanded more and more from the manufacturing chemists, and we have learned the way to be entirely independent of outside sources of raw material in so many lines of manufacturing which are essential to the best national life. Manufacturing chemistry is peculiar in requiring ripe experience in detail by those in direct charge of operations, as well as scientific knowledge of the proc-

esses used by those in general control, and this brief reference will suggest to you the great chain of industries vital to the independent commercial success of our nation, which have been and are being built up in this country now that the supply of "Keystone" products has been made available by the by-product oven. After so many years of neglect, the progress we have made in the development of these closely interwoven industries is both remarkable and gratifying.

PERFUMES ARE ESSENTIALS.

I will not at this time discuss the sanitary and medical supplies needed in the medical departments of our armed forces, but salicylate of soda and magnesia, aspirin and salvarsan are illustrations of what our medical forces owe to coal distillation products. Perfumes may seem rather aside from preparations for war, but they are practically essential in the manufacture of soaps, pastes, ointments and salves as well as for less important uses, and the base of very many of these perfumes is chlorinated toluol and benzaldehyde.

While very much of our attention is necessarily occupied in the actual conduct of the war and the production of the necessary supplies in a variety which we are only beginning to realize, we are also giving much thought to what is to come after the war. I have endeavored to suggest briefly the many lines of important industries that have grown directly or indirectly from the "Keystone" products of the distillation of coal, and others will occur to you.

It is most satisfactory to note the courage and energy with which American manufacturers have entered these fields, and the sound commercial basis upon which many of these industries have been established. When the military requirements are over and these manufactures have been adjusted on the basis of peace requirements, let us hope that our manufacturers, assisted by well-con-

sidered Government aid, may be able to reach an even broader development of these industries than we have discussed and produce all of these hitherto somewhat unfamiliar products necessary for our national life. We have always excelled in mechanical products, although we have often permitted other nations to benefit more largely than we from our inventions, and this great emergency has shown that we are equally capable in chemical manufacturing, once we are assured of the raw materials and are aroused to the importance of these lines of industry.

OUR BY-PRODUCT COKE OVEN INDUSTRY IN THE WAR.

Discussion by WILLIAM A. FORBES.

Chairman, Benzol Committee United States Steel Corporation, New York

The paper prepared by Mr. W. H. Blauvelt is, on account of war conditions, of particular interest at the present time; there is no one I know more capable of presenting a paper on the subject in question than Mr. Blauvelt.

The company with which Mr. Blauvelt is connected has been a pioneer in the development of the by-product coke oven in Europe and in this country, and is recognized as the prime leader here in improvements relating to the recovery of coal by-products and their further treatment in the manufacture of the more advanced products, many of which are specified in Mr. Blauvelt's paper.

It is gratifying to note that the by-product coke plants operating in this country, in conjunction with those now in course of construction, will result in a greater proportion of our country's coke being produced in by-product than in beehive ovens this year. In 1911, for instance, only 22% of the total coke produced in this country was made in by-product ovens. This increase in by-product coke oven capacity has occurred in spite of the very greatly increased cost of installation in recent years, entailing now practically three times the investment required in 1911.

At present, there are 8,173 by-product coke ovens in operation in the United States, having an annual capacity of 29 million net tons of coke, and there are

2,278 by-product coke ovens in course of construction, most of which are expected to be completed this year, with an annual capacity of 10 million net tons of coke. The total number of by-product coke ovens in operation and in course of construction in this country, therefore, amounts to 10,451 ovens with a capacity of 39 million net tons of coke per annum.

Of the above number, the United States Steel Corporation has in operation and in construction, including 240 ovens operated for its account, 3,112 by-product coke ovens, having a capacity of 12,850,000 net tons of furnace coke per annum. The United States Steel Corporation, therefore, has 30% of the total number of by-product coke ovens and 33% of the total by-product coke capacity of this country.

So far as types of by-product coke ovens are concerned, the art has progressed to the point where there is practically no difference in results obtained from representative plants of the leading systems.

As Mr. Blauvelt implies, this country would have been in desperate straits for the high explosive bases—toluol, ammonia, benzol and certain other coal by-products—had it not been for the by-product coke ovens. It is fortunate, as events proved, that the recovery of benzol products from by-product coke oven gases had been thoroughly investigated, plans for installations formulated, and construction of plant started in this country prior to the outbreak of the European war. This allowed the recovery of the essential by-products early in the war.

Furthermore, the Allies would have been very severely handicapped in the earlier stages of the war, prior to the entry therein of this country, had it not been for the toluol and benzol produced from the by-product coke ovens of the United States, a large proportion of which was converted into tri-nitro-toluol and picric acid for their use.

As is now well known, toluol is the base of tri-nitro-

toluol, which is one of the most deadly explosives used in this war. Toluol, although at present utilized practically entirely for explosive purposes, is also the base of certain dyes, particularly the dye used for the cotton khaki worn by our soldiers. Benzol is the base of picric acid, which is largely used as a high explosive; and, as is also well known, benzol is the principal base of the so-called coal tar or aniline dyes. The term "coal tar" originated when these products were recovered from coal tar from retort gas works before the extraction of benzol from by-product coke oven gases was developed. The amount of benzol products in by-product coke oven tar is negligible.

Another by-product of service as an explosive base in the present international emergency is naphthalene. Naphthalene, which is extracted with the benzol products, is also used very successfully as the base of aniline dyes and ranks second to benzol for use in this respect. It is very gratifying to know that this product, naphthalene, which used to be the bane of existence to coke oven operators before benzol plants were installed, has such great value as a dye base.

Ammonia is used in the manufacture of ammonium nitrate for explosive purposes, and nitric acid, which is essential in the manufacture of ammonium nitrate, is also being recovered from by-product ammonia. As is well known, ammonia is extremely valuable in the form of ammonium sulphate for fertilizer purposes.

The United States is now able to maintain a commanding world position in the production of aniline dyes and it would appear that aniline oils, which are the intermediate products for the dyes, and probably the dyes themselves, can advantageously be manufactured right at the by-product coke plants, where the principal essential raw materials required for their manufacture are available.

The development of processes whereby nitrogen, which is the ultimate base of all high explosives, is being

extracted from the air is also of prime importance in connection with the present war. Germany was the first nation to insure an adequate supply of nitrogen by this means, and its present strong position can properly be attributed more to its scientific and commercial development of these processes than to any other one cause.

The yield of benzol products depends to a very great extent upon the character of the coal used, the general rule being that the higher the volatile matter in the coal the greater the yield of by-products. It has been determined that the total yield of benzol light oils is not materially affected by reducing the coking period, but that in certain cases the proportion of toluol to benzol in these light oils decreases as the coking time is reduced, with a proportionate increase in benzol.

The practice inaugurated some years ago, which is now followed at most by-product coke oven plants, of pushing the coke from the oven while still dark in color, has a beneficial effect on the recovery of by-products.

The greater yield of by-products due to high volatile matter in the coal is, however, at the expense of coke yield, and it is a matter of somewhat delicate calculation, based on local conditions, source of coal supply, etc., to determine to what extent high volatile coal should be used. When all is said and done, coke is the prime product required from most by-product coke oven plants, except in emergencies, and decrease in coke capacity, due to lower coke yield following the use of a larger proportion of high volatile coal, results in shortage of coke for use in pig iron and, consequently, steel production. This, of course, does not apply to such a degree to by-product coke plants which have a greater coke capacity than company requirements.

Mr. Blauvelt refers to the fuel conservation in the manufacture of by-product coke as against beehive coke resulting from the use of the tar and surplus gas recovered and the greater coke yield. As an instance, the coal thus saved in the year 1917 at United States Steel

Corporation plants amounted to 3,200,000 net tons or 64,000 carloads of 50 tons each, movement of this number of railroad cars thereby being saved for employment in other directions. When we consider last winter's conditions of transportation, it is easy to recognize that blast furnace and steel works operation would have been still more severely curtailed without by-product coke ovens.

While on the subject of transportation, we should not overlook the great advantage in certain localities of by-product coke ovens in allowing transportation of the coal to the coke plants by water from mines adjacent to navigable water. An example of this is the Clairton, Penna., plant of the Carnegie Steel Company, where, for the 768 by-product coke ovens being installed, 4,900,000 net tons of coal will be required annually, most, if not all, of which will be transported in 1,000-ton barges on the Monongahela River. On the basis of this entire amount of coal being shipped by water, rail transportation amounting to 98,000 carloads of 50 tons each would be saved per year.

Of all the ammonia, benzol and toluol produced in this country, about 80% is the proportion derived from the by-product coke oven plants of the steel and allied industries, now in operation or construction, the remaining 20% being mostly obtained from gas works. It will thus be seen that the steel industry is largely responsible for the position maintained by our country today respecting production of the bases of high explosive products.

In conclusion, we hope that in view of the services rendered to our Government and civilization by steel manufacturers in providing additional by-product coke oven capacity at heavy expense, they may be assisted, by suitable legislation if it becomes necessary, in securing and retaining a fair share of the world trade in these coal by-products and their derivatives. In the four years of the present war we have become independent of Germany in the dye industry, and there is no reason why we should not continue so under efficient tariff conditions.

EVENING SESSION

The evening session of the Institute was held in the grand ballroom of the Waldorf-Astoria. After dinner, President Gary called the meeting to order and said:

Gentlemen: I bid you eleven hundred welcomes. (Applause and cheers.) This evening the lions and the lambs sat down together. I refer to Washington and the gentlemen of the iron and steel industry. The latter are the lambs, but they are still unharmed. Reference was made this morning to the fact that the steel industry has been fairly and conscientiously treated by the powers that be, and the prediction was made that so long as the manufacturers of iron and steel deserve to be treated right that was the treatment they would continue to receive. You have heard some of those best acquainted with the details on Washington matters, so far as it affects us and our business. We have here tonight a representative in the War Industries Board who is able and willing to listen, to discuss and to decide every question presented upon the merits; a man who has been connected with the iron and steel industry and who is qualified to pass upon the questions incident to our business; a man who has shown by his acts that he is firm in the endeavor to protect the Washington interests, which means the best interests of the entire public, and we have been fortunate enough to secure his presence on this occasion. It is my pleasure to introduce as the first speaker Mr. J. Leonard Replogle. (Applause and cheers.)

MR. REPROGLE: Mr. President, ladies, gentlemen and fellow members of the American Iron and Steel Institute: The last time I was privileged and honored to address the American Iron and Steel Institute was at the Chicago meeting four years ago, and I made what I considered a very firm appeal for the establishing and maintenance



Waldorf-Astoria - May 1914

of proper extras and differentials on various iron and steel products.

So far as proper prices, extras and differentials are concerned, you do not, at present need any help from me, as this is now looked after in a more capable way by the official committee you have appointed. My plea during the past ten months has been one of a different character. It is for extra tonnage—extra production of iron and steel needed so vitally in this terrible war. If there is one thing in this world of which I am positive it is this: That the direct or indirect war necessities of the United States and Allied Governments for steel will require all the steel mills can produce this year at least. "War necessities" is rather a flexible term and it has been given much thought and consideration by those in authority at Washington.

I had a conference Wednesday with the representatives of the corset industry. It developed that their profits last year from this great industry aggregated forty million dollars, and their requirements in steel are from fifteen to twenty thousand tons of high carbon spring steel annually. I am no authority on corsets, but after a very thorough discussion of the subject with the gentlemen who represented that industry in Washington, I am not in a position to dispute their claim that corsets are an essential industry. (Laughter.)

There have been many lists of so-called non-essential industries prepared at Washington, but they have never been officially issued as there has never been complete agreement on this subject. Among other articles on the list which was prepared by one department, were poker chips and playing cards, and I know my dear friend Uncle Joe Butler would strenuously object to placing these, to him, vital necessities on such a list. (Laughter.)

All industries are essential from one standpoint or another—if no other, from the standpoint of the owner—and we have preferred to reverse the procedure and prepare a list of the more essential industries, giving them

such preference in steel supply, fuel, transportation and labor as are necessary to get the results for which we are all striving.

It may be surprising to many of you to learn that we now have unfilled orders on the books of the steel manufacturers and on our desks at Washington, for 16,800,000 tons of steel for the United States and Allied Governments, and the orders are coming in at a greater rate than they are being executed, although I believe we are near the peak of production.

The difficulties of some of our gallant Allies are very great. Coal in Italy is \$140 per ton, and their steel industries are working under great disadvantages. A very large percentage, probably 75% to 80% of the steel and coal of France are now either in the hands of our enemy or within the range of his guns. The requirements of our Allies will be enormous, and the least we should do is all that we can do to give them steel when and as they need it. (Applause.)

The railroads of our country need more rails for safety and efficiency of operation, and it is very difficult to give them any increase without restricting the production of projectile steel, which is largely rolled on rail mills. The forging plants are now getting under way and have just reached the point where their consumption of projectile steel will be an extremely heavy factor. The ship-yards have their ways built and many keels laid, and under the direction of Mr. Schwab (applause), will require vast tonnages of steel.

His program for next year is at least double that of this year and we must furnish him the steel to complete the great work he has to do and for which he is so well qualified. (Applause.) The appointment of Charles M. Schwab was an epoch in this war—a great Allied victory and one which caused great consternation in Germany. (Applause.) The expressions of approval of the representatives of the Allied Governments dealing with us

were of such a nature as to leave no possible doubt as to how it was received by them. (Applause.)

When Mr. Schwab called me to his hotel a day or two before he accepted the appointment, and told me about it, I felt a measure of satisfaction and joy beyond my expression. I think he has the most dominating, and at the same time the most winning, personality of any man I have ever known, and his enthusiasm and energy will produce such results in shipbuilding as will astonish the world. (Applause and cheers). I may be a little prejudiced in his favor on account of the great tribute he paid me early in my Washington experience. After one of our steel meetings, Schwab, Dinkey, Topping and others were in Mr. Schwab's room trying to figure out whether three aces were better than three kings, and during the usual discussions incident to such an entertainment, Schwab asked me if it was true that my salary was only one dollar a year, and upon my answering in the affirmative, said: "By Gad, Rep, I believe you're worth about twice as much as your are getting." I submit, was this not a perfect tribute? (Laughter.)

I am going to get back at him by telling you a story I heard about him the other night in Philadelphia. A certain gentleman had gone for a little trip to Virginia Hot Springs, and upon his return, met a friend, who is also a friend of Mr. Schwab, and told him about the enjoyable trip he had there and incidentally mentioned that he had met Charles M. Schwab. His friend said: "Was Grace with him?" to which he replied: "I don't know her name, but she was a darned good-looker." (Laughter.)

There has been another appointment in Washington which properly met with great approval, Bernard B. Baruch, Chairman of the War Industries Board. (Applause.) He is a man of great ability, determination and quick decision, and is doing wonderful work in this great fight to keep the world a decent place to live in. My association with him has been such that I can say positively that every move he has made has been protected by fairness and he has done everything possible to promote

and foster prosperity of industries, consistent with the one big object of winning the war. He has a most difficult position and is filling it with great efficiency. No important steps have been made by him without full consultation with the industries affected, and, where possible, the ideas of the leaders of these industries have prevailed.

Some of you gentlemen have felt that we on the War Industries Board have been, at times, critical and severe. There have been times before the acute necessities of war became known, that a few—a very few—manufacturers, we felt, had been governed a little too much by commercialism and did not devote sufficient of their products to the lines we felt most necessary, and we have not been slow in calling their attention to this fact.

At the meeting some weeks ago in Judge Gary's office, when the 100% pledge was adopted, I think there was a clearer understanding of the necessities of the situation; and it is incumbent upon me to say, and I do say with the greatest of pleasure, that today 100% of the steel manufacturers of this country are doing their utmost and that there is not a single exception to this rule. (Applause). You are all doing wonderful work, and in the history of this great war the work of the steel manufacturers will stand out in the most glowing chapters.

I have often felt that one of the greatest achievements of history was accomplished at the meeting of the steel manufacturers and the War Industries Board in September of last year. The manufacturers realize fully that, due to the abnormal conditions created by the war, prices had risen entirely too high and that the burden of our gallant Allies was already so heavy that the law of supply and demand must temporarily be abandoned. I do not think our wonderful President has made many more important or proper decisions than that our Allies in this fight were entitled to the same prices as our own Government on the materials necessary to win this war. The Steel Manufacturers and the War Industries Board mutually agreed upon prices, which were officially ap-

proved by the President, and which—while involving reduction in some cases as much as 75% from the standards then prevailing and which were constantly increasing—I think today are considered by all of you fair and reasonable. The difference in a year's output meant a saving of between two thousand and three thousand million dollars. There was no statute of law for this action and the War Industries Board was not vested with legal authority to compel such an action. It was, therefore, entirely a voluntary one on the part of the steel manufacturers, and it is, I believe, one of the most glorious chapters of the war. (Applause.)

We knew that understanding by all manufacturers of the acute necessities of this war was all that was needed to secure the 100% co-operation which we are now receiving from them. We believe that this same understanding is due the steel workers in your mills and factories. I do not feel that they entirely appreciate what a great and glorious part they can play in winning this war—in working steadily, in working to the highest degree of efficiency—which would come to them with a full realization of the necessities.

The industrial worker in these days is almost as important to the successful conclusion of this war as the man in the trenches. He is playing no small part and every effort should be made to have him realize this. Much has been done along this line, but I believe that much additional can be done by mass meetings such as have been held recently by the Midvale Steel & Ordnance Company, Jones & Laughlin, the Lukens Steel Company and other manufacturers. I think many of you have seen the poster used by these companies and the text of which I propose to read to you, as I feel that is one of the best methods of instilling in the worker the enthusiasm for his work, which is necessary to get the best results. And, incidentally, I was in Johnstown last week and the general superintendent of the plant said that since these meetings they have had a ten per cent increase in coal production,

and great numbers of men are coming to their foremen and soliciting the opportunity to work extra time. The first poster reads: "NOT JUST HATS OFF TO THE FLAG BUT SLEEVES UP FOR IT!"

Representatives of the Midvale Steel & Ordnance Company posted these throughout their works and all of their plants, and they inserted full page advertisements in the local papers at Johnstown, Pittsburgh, Coatesville and other places. The second poster reads:

"At a recent meeting with representatives of the United States Government, the Executive Offices of this Company made the following pledge:

For myself my corporation, or my firm, I pledge the prompt production and delivery of the largest possible quantity of material in our Departments that is or shall be required by the United States Government for the necessities of itself and its Allies, and agree that all other lines of our business shall be subordinated to this Pledge, and all this in accordance with the request of the War Industries Board.

"In order to carry out the spirit of this Pledge, it is necessary to have the hearty co-operation of every employee.

"The maximum prices at which most forms of steel products can be sold have been fixed by the Government authorities, so that this Works is now being operated practically as a Department of the United States Government.

"The tonnage which can be produced each day, of course, depends primarily upon the workmen at the Furnaces, Mills, and Mines. It is, therefore, the patriotic duty of every employe to report for work each day unless prevented by sickness or some other cause beyond his control; and while on duty to devote every energy to the efficient performance of his particular work. In no other way can we produce the tonnage of steel required for shipbuilding, maintenance of railroads, manufacture of shells, and all the other uses for which steel is required in the prosecution of this great

WAR IN DEFENSE OF CIVILIZATION

“Our sons and our brothers are baring their breasts to the foe on the battlefields of France, ready to make the supreme sacrifice for our beloved country. It is both our patriotic duty and our sacred privilege to do our part to see that not one of these lives is unnecessarily sacrificed because of lack of equipment which can be furnished through our labor.

“Let us put our hands and our hearts to our respective tasks in the spirit of the immortal Lincoln, as expressed in his matchless utterance on the Battlefield of Gettysburg:

“The world will little note nor long remember what we say here but it can never forget what they did here. It is for us, the living, rather, to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us; that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion—that we here highly resolve that these dead shall not have died in vain; that this nation, under God, shall have a new birth of freedom, and that government of the people, by the people, for the people, shall not perish from the earth.”

JUDGE GARY: It is only rendering justice to say that your President has received letters from the officers and from practically every one of the corporations or firms engaged in the manufacture of iron and steel, substantially in accordance with the sentiments which were expressed in this beautifully worded poster.

The powers in Washington, you have noted, some time ago decided that appointments should be made not because of political ardor, not because of any feeling of partisanship for any branch of the administration, nor for any reason whatever, except efficiency. Without extending my remarks, it is enough to say to you that with all our hearts we welcome to this Board a man of our own family, a man who has long been in our hearts

and in our minds; who has been esteemed and loved because of his qualities, and because of his merits; a man who is competent, a man who is brilliant; one of the best of friends, one of the ablest of our members; respected because he can do more than anyone else to assist in putting into practical effect the urgent demand of Lloyd George, when he said to this country: "We need, we want ships, and ships and more ships." It is my pleasure to present Mr. Charles M. Schwab. (Applause and cheers.)

MR. SCHWAB: Mr. Chairman, ladies and gentlemen of the Iron and Steel Institute: For a good many years we have met here upon these enjoyable occasions, and as far as I have been concerned, we have always met with a heart full of friendship and levity. As I expressed it last night, "playing the part of clown and entertainer for the edification of my delightful friends in this assembly." (Laughter.)

Tonight, when I listened to the introduction of your president, my old and esteemed friend Judge Gary—when I listened to the flattering remarks of one of my boys, Leonard Replogle; when I saw the burst of enthusiasm with which you greeted me, I am obliged to confess that, tonight, I face you with a heart so full of responsibilities and cares, and a heart so burdened with the thought that my friends in the iron and steel trade for so many years have placed a confidence in me that I must not disappoint; with a heart so full of emotion at the universal approbation and approval of what the President has seen fit to do, that I must, of necessity, speak tonight as the heart dictates and not in a tone of levity, but in a tone of peculiar responsibility in connection with the situation which the United States finds itself tonight. (Applause.)

Before proceeding upon that part of my remarks, however, I must take occasion to reply to my friend Judge Gary, about the flattering things that he has said. For twelve or thirteen years, since we had our first meeting in a little room of this hotel, I have had the honor and privilege of sitting by his side at these meetings. In all

those years there never has been a time nor an occasion when he has not been the true friend of myself and as well, I think I can say, of every single member of the iron and steel institute. (Applause). In all the years that have gone by I have so exhausted my vocabulary in the praise of the Judge that I find it difficult to find new words and new phrases to adequately express what is in my heart toward him. But what are words upon such an occasion, if you are able to place your hand upon his shoulder and say: "My dear Judge. You have been a true friend. I hope you always shall be. You no more desire to be my friend than I desire to be yours." (Applause.)

Now, I come to another gentleman of the fraternity with whom I do not need to speak so seriously. He paid me a high tribute to speak of the glowing things and brilliant things that I may be expected to accomplish. When he told that story, Replogle really paid me the highest tribute he could pay me, a man of 56. He little thought that I might in turn say some things about Leonard Replogle—but they are not the kind of stories that I can tell tonight. I would not want anybody to infer from that, any more than they would infer—don't laugh at this—I would not want anyone to infer from that any more than they would infer from his other story that he played poker, that the stories which I might tell, may even be embellished by a shadow of truth. But, then you must remember that Leonard Replogle can well afford to tell these stories, because he is generally known in the iron and steel trade, especially in Cambria County, the place where he and I originated, as the Adonis of the iron and steel industry. True, I have not heard that title applied to him until he told me about it himself. (Laughter). I could say a good deal more, but I see Mrs. Schwab up in the gallery shaking her finger at me, and so I better stop. But, there is one thing I will say of Leonard Replogle. The iron and steel trade are to be congratulated on the man that we have in Washington as

director of the iron and steel branch of the governmental business, Leonard Replogle. (Applause.)

From our first meeting in Washington with Mr. Replogle there never was a time that he did not impress upon every man who was inclined to be fair, and all were inclined to be fair, the fact that he kept constantly before him the importance of this great industry, and endeavored to treat us fairly in every particular and in every branch of the business, and in the United States there is not a better informed man than my esteemed friend and boy Leonard Replogle. (Applause.)

And now, gentlemen, let me come to a part of my address of which I shall speak with more difficulty than any other part, and that is the appreciation of you men. Next to Willis King and Uncle Joe Butler, it will perhaps surprise you to know that I am, perhaps, one of the oldest steel men in this great assembly. A man that has worked for nearly forty years with his friends in the trade, and possesses the confidence and the appreciation that I seem to possess at your hands tonight, would indeed be an ignoble character if his bosom did not swell with pride, and if he did not feel the respect and love that I feel for every man here. I have yet to see the man, however exalted his station, that was not pleased at the approbation of his fellow men. I have yet to see the man who does not put forth his best effort under the encouragement of his fellow men. And I have yet to see the man, who is worthy of the title of true man, that did not think, that any man will make his greatest effort under the spur of the approval of his fellow men. And whatever my merits may be; whatever I may contribute to this program, of one thing I am absolutely certain, and that is that the approval of you gentlemen in this industry has had such an effect upon the country at large as to have swept over it a wave of confidence and enthusiasm, a wave of enthusiasm and patriotism, a wave of encouragement, that must carry on any project to a successful conclusion. (Applause.)

Therefore, if no other good will result, the good of your approval, the enthusiasm and encouragement which it has evoked, will, beyond question, help tremendously in this great undertaking.

Now, I hope you will pardon me if I take just a little time to tell you something about it. I am not vain enough to believe, nor is any man worthy of the name vain enough to believe, that any one individual can be a very great factor in any enterprise of such magnitude. What is required is the united effort of everybody, and this undertaking is so fast and so important, that no man or group of men can be successful without the encouragement, help and approval of every man, woman and child in this great United States of ours.

I want to take this occasion, also, to say something more. Many people unacquainted with affairs at Washington are prone to criticise what has been done. Personally, I don't mind saying that I felt as many others did, that matters in this direction had not gone well. I would not be fair to myself, nor would I be fair to you or the people, if I did not take this occasion to say that in my opinion the work in Washington by Mr. Hurley, Mr. Piez, General Goethals and the people who have been at this job has been magnificent. (Applause.) It has been difficult for people to appreciate, but let me tell you this story of ships.

When this war started every great yard in the United States capable of producing ships was taken up by the Navy—practically all of the yards—and therefore the yards to produce ships for the Emergency Fleet had to be created. Now, you, as practical men, know what it means to create a new works, to organize that new works and to make it quickly efficient. I have already examined about sixty-five or seventy per cent of the ship producing capacity in the United States, and I am obliged to say that the work has been magnificently and efficiently accomplished. (Applause.) Real credit must be given to the men who have done that work. Do not let us

enter into this job with a spirit of criticism; let us enter into it with a spirit of approval and encouragement and results are bound to come. I myself, since being engaged in this undertaking, feel such a tumult of patriotism within my own breast, such a feeling of enthusiasm, such a desire to work and do something at this job, that if I can but only impart some part of the feeling in my own bosom to those associated with me in the yards, I feel, gentlemen, I will have accomplished my task and merited your approval.

Secondly and more important. I am not a believer in the fact that we at Washington cut very much of a figure in this great undertaking. After all the men who will have the real responsibility of this great undertaking are the men in direct charge of the shipbuilding yards, and the accessories for the ships. We in Washington can do little more than encourage and grease the wheels of progress, but the real responsibility rests with those who have undertaken the work at their various works, and shops and yards. And there again the task and responsibility rests not alone with the management, but with the foremen, the superintendents, the sub-foremen, the head workman, yea, even the workmen themselves and as a unit only, and by giving proper credit to them and proper encouragement, the result will be accomplished.

Now, gentlemen, don't think we are not accomplishing anything, because we are. Napoleon said: "Let me win my first battle and my campaign is won." We have started on this shipbuilding program during the past six weeks or two months with a wave of enthusiasm and confidence, and we have started at a pace that cannot be stopped, and with your approval, appreciation and encouragement, will go on to a successful issue.

You will probably be pleased, and no doubt surprised, when I tell you that during the month of May, ended today, the United States produced and placed in commission ready for service—I don't mean launched, but I say placed in service—250,000 dead weight tons of ships! (Applause and cheers.)

I was over yesterday at the beautiful plant of the Submarine Boat Company, of which Mr. Carse is the president, who has done so nobly—taking that swamp last September and launching his first ship on Decoration Day, yesterday. (Applause.) I was over to the plant, and when I saw that beautiful ship glide down the ways I said to the people: “Do you realize that for every working day of this month of May, two such beautiful ships as that were placed in the service of our United States Government?” (Applause.)

Now, I am sure that the month of May is going to be the least productive month we have had. (Applause.) I am not going to make any predictions; they are bad things to get out of if things go wrong. But you may be confident that with the same spirit prevailing the country is bound to do better, and that this Government and Lloyd George will, within a reasonable period of time, have that which they require. But what is necessary?

I have already enlisted the support of every industry in the United States in the shipbuilding line, or in the accessory line, that is possible to enlist at this time for this work. But I felt that it was far from what was needed, for the amount of ships required by our Army and Navy was so stupendous, and I felt that we had to go still further than that, so during this past week we have contracted for new works, authorized and contracted for new works aggregating perhaps \$200,000,000 or \$250,000,000, that will increase the shipbuilding capacity of the United States at least three million tons more per year. (Applause.) I do not hesitate to say that I should have increased it double that if I could have found the outlet or the ways and means of so doing.

The Lake Department alone, which has made a wonderful showing, and great credit is due Mr. Passano, whom I have seen there, predicts that they will produce this year between four and five hundred thousand tons of shipping on the Great Lakes alone. I told him it wasn't half enough, and I have their pledge that the proper extensions

will be made, and that during the coming year we may expect out of the Lake District alone at least a million dead weight tons of shipping. (Applause.)

I cite these figures, gentlemen, only to give you some idea of the stupendous program ahead of us.

In January we had 60,000 workers in the shipyards. Today we have 350,000 workmen and another 350,000 in the engine and boiler and accessory works of our ship work, making in all nearly three-quarters of a million men today engaged in the shipbuilding industry, to say nothing of the steel that goes into it or the kindred products.

Now, I am taking the opportunity of saying that I am very proud of the people in the steel industry. Replogle is very nervous and fearful that we are not going to get enough steel. He may be right, but I am not worrying much about it. I know that the shipbuilding program is first on his list, and we will let the other fellow worry. Carse said to me the other day: "Aren't you worrying about borrowing so much money"; I said: "No, I have got the money and I will let the banks worry about that now." (Laughter.) I know Replogle is going to give us the steel. I know the steel people are going to produce it. I may be more optimistic than he, but it is because I have a good deal of confidence in the fact that the steel manufacturers of the United States are going to give us this year and next year all the steel we require for the carrying out of this great program. (Applause.) And, I know of no industry in any direction, or anywhere, that has so nobly, so patriotically, so willingly and so enthusiastically done their duty by their country as the iron and steel industry of the United States. (Applause.)

Now, gentlemen, I have been serious tonight. I have not talked in the usual light tone. My whole heart and soul is in this one project. I want you with me and I want you to help me succeed; not for myself, but because you have given me your confidence. If I succeed, you succeed. If you succeed the steel industry, the greatest

industry in this country, succeeds. If we as a body of men representing that great industry succeed in this undertaking, we can well say as Horace said of old: "In the years to come it will delight us to have wrought these things," and we will sit down in a world so full with liberty, democracy and good fellowship; a world so full with good men and good women, and talk over the things that we have so successfully accomplished.

With a social democracy that shall bring happiness and prosperity to every man, woman and child in this great country of ours. We will feel rising within our soul that one thing than which there is no greater, a sense of patriotic satisfaction that we have done our duty; that we have done it because we have been asked to do it, but have done it with a heart full of love of our country, with a heart full of love of our fellow men, with a heart full of love of each other in this great steel industry, and as we grow old, gracefully and happily, with victory assured, because victory there must be, we will spend some of our meetings in this great Iron and Steel Institute, in thus reminiscing over the days of trouble, long gone by, happily enjoying good fellowship, good friendship, good business prosperity and happiness. My good wishes and God bless you, every single member of the American Iron and Steel Institute. (Hearty and long continued applause.)

JUDGE GARY: Sufficient steel will be furnished by the manufacturers. (Applause.) They have dedicated their works to the interests of the government of the United States and its Allies. If there is not sufficient capacity the works will be extended and the capacity increased. (Applause.)

The reference to Napoleon causes me to say that in the present terrible campaign in France the enemy may win the first battle, and the second battle and the hundredth battle, but they will never win the war. (Applause and cheers.) We have the courage and the ability and the determination which will finally enable us to conquer,

because we stand for and fight for the right, and the right is certain to prevail sooner or later. (Applause.)

Oftentimes in the past we have dreaded the meeting of Congress, and we have looked anxiously for its adjournment. Congress has been made up of many men of many minds, and often the majority have decided in opposition to what we believed was for the best interests of the country. But there were some men who always voted right, who always worked for the best interests of the people, and conspicuous in that class is a gentleman whom I will now introduce, ex-Congressman John J. Fitzgerald. (Applause.)

MR. FITZGERALD: Mr. President, ladies and gentlemen of the Iron and Steel Institute. If I appreciated that my resignation from Congress would have given such joy to this very great and important industry of this country, I would have resigned ten years ago. (Laughter.)

After all, the fear of Congress, is one of those peculiar things that seems inherent among the American people. They select men in their own communities whom they regard with esteem and affection and send them forth to his official duties with great enthusiasm, but just as soon as they get to Washington distance no longer lends enchantment. The Congressman seems to be regarded in an entirely different aspect by those people who have committed their cares and responsibilities to his keeping.

I suppose Judge Gary's remark was somewhat akin to his statement that the American Iron and Steel Industry in opposition to the Government are to be regarded as the lambs. If they are the lambs at this time in this country, they are the flock that are gamboling on the White House green. (Laughter.)

I am very much interested in the remarks of Mr. Schwab. You know I am out of politics and I am free from the restraints that hamper men who are in Congress; and now that I am out, I can afford to tell the truth, the whole truth and nothing but the truth. (Laughter.)

I am embarrassed by my environment on this occasion,

when I am associating with great captains of industry into whose company a few years ago I would have hesitated to come.

I was very much interested in Mr. Schwab's remarks, and of the great compliment paid to him by his appointment, and of the disposition that the administration has shown towards the appointments of men to office who are outside of the party. Of course, it was not realized that the party in power had so many men of great capacity whose services they had to utilize before going outside of the party. (Laughter.) But now that men like Mr. Schwab and Justice Hughes and some other distinguished democrats have been taken care of, there may be an opportunity for some progressives like Mr. Perkins, and some Republicans, to find an opportunity to serve their country at this time.

Let no one imagine that Mr. Schwab in his great undertaking will finish his work without making mistakes. If I were not certain that he would make many and great mistakes before he was finished I would regard his appointment as a failure, because nineteen years of service in public life convinces me that the public official who never makes a mistake never accomplished anything that is worth doing. (Applause.) There is not a man in any business or industrial enterprise which has been successful, who has not made some great mistake in his career. What is needed is a man of capacity, of enterprise, of intelligence and of courage to do whatever he thinks is the proper thing to do, and if he make mistakes he learns his mistakes so quickly that he rectifies them. But if they do not have the courage to act or to do, they will flounder around in indecision and uncertainty and they will prevent progress being made at all.

One of the things the American people must learn at this time is not to magnify the mistakes that are made by the administration or by those charged with the conduct of the affairs of the government. (Applause.) No set of men could have undertaken the tremendous enter-

prise upon which this Government has entered and not have made great and greivous and serious mistakes. A representative of the British Government said in the House of Commons last year that the critic has the supreme advantage over the administrator that he can say that if he had been in the position of the administrator the mistake would not have been made. This assertion the administrator is unable successfully to challenge. Mistakes have been made, and mistakes will be made, but in comparison with the errors of judgment the accomplishments of our Government have been wonderful and have astounded the world. Lord Northcliffe told me repeatedly that he was astonished at the tremendous results that have been accomplished in so brief a time in this country. (Applause.)

I recall very well the occasion, less than a year since, when the Shipping Board applied to Congress for almost a thousand million dollars to undertake a program of some eleven hundred ships, of over three to four billion deadweight tons displacement. No one thought much of it, but not only had the Navy secured the facilities that were free, but at that time in this country the available shipbuilding facilities that had not been taken over by the Navy Department had been contracted for by foreign governments under long term contracts, and one of the things that was necessary to be done was to commandeer these contracts and to arrange with the shipbuilding plants in many districts to make room for additional ships. And when criticism is made of the Government and of the Congress, we must not forget what was done by the Congress in a very brief time.

I recollect that the fiscal year 1916, which ended June 30th, 1917, saw appropriations for the support of our Government aggregating what was then considered to be the enormous sum of \$1,500,000,000, and yet inside of the brief space of seven months Congress of the United States, including authorized advances to the Allies of the United States Government, authorized the expenditure

of the tremendous sum of eighteen billions, and contracts were authorized for nearly three billion dollars additional. That was twenty-four per cent of the total expenditure of all the Governments then engaged in the war, during the three year period in which they had been engaged. It was equal to the entire expenditure of the British Government, including its colonies, up to that time. It was sixty-five per cent of the expenditure of Germany and Austria-Hungary. And while that enormous sum of money was placed at the disposal of the administration in order to prepare properly and quickly, to enable the government to participate in the war, let me illustrate how rapidly that tremendous amount was necessary to develop the organization of our Government.

When war was declared on April 6th, 1917, there were sixty-three officers on duty in Washington in the Ordnance Department and less than three hundred throughout the entire United States, with six hundred employees. In seven months the organization in Washington was extended to over six hundred officers and more than three thousand officers outside of Washington, and to ten thousand civilian employees. During these seven months seven hundred and eighteen contracts, aggregating almost sixteen billions of dollars, were made by that department, and contracts for supplies and munitions to an extent of double the contracts made by the British Government in its three years of the war were made by that department during that period of expansion. Those of you who are engaged in great business enterprises will appreciate the difficulties of going out into the business world and obtaining technical services required for any new work during the extension and organization of a department to make it possible to carry on the business to such an enormous extent.

Never before in the history of the whole world has the genius and the capacity of the American people had to meet so great an emergency as it has met during this world crisis. (Applause.) No one expected, nor did

anyone anticipate that within such a brief time the American people would be participating in this war to the extent to which they have been participating, and not even the best informed or the most progressive figures in our military service had any conception that the military would be used to such a tremendous extent as it has been in this war.

Just prior to the outbreak of this war, the United States military regiments had two to four machine guns, and now one-third of our regiments are trained and equipped to handle machine guns. Machine guns are to be utilized, heavy artillery are to be utilized, to an extent that no one ever anticipated. During the preparation of one of the appropriation bills a request had been made for practice ammunition for small arms amounting to eleven millions of dollars, and within a period of a month an additional request for two million dollars was submitted to Congress. In two months afterwards a request was made for seventy-nine millions additional. This was for practice ammunition merely, to teach the men to shoot. It occasioned some surprise even among the hardened members of Congress who were accustomed to these extravagant demands of the military service, and a request was made to ascertain just how these figures were reached. When the explanation was given, it did not seem so extravagant. It figured 250 rounds per rifle to teach men to shoot and 3,000 shells for each machine gun that was under contemplation. And the number of rounds of ammunition that this money would supply, in order to teach the American military to shoot accurately and effectively, amounted to a billion six hundred and sixty million rounds. A member of the Committee, on which I had the privilege of serving said: "Don't make that statement public, because the American people, if they heard it, will be convinced that if, instead of shooting that ammunition away in practice, it was shot at the German armies, the war would be ended before you reached the balance of the ammunition." (Laughter.)

No one, not even the men in the military department of our government, well appreciated the tremendous quantities of ammunition and materials of different character that were being used when this war broke out.

The steel helmet, the one which every one on the firing line wears, was a relic of antiquity. A few show soldiers in some of the continental armies used them. And yet experts decreed that, in order to protect the men from the danger of shells or serious wounds from shrapnel, it was necessary that every man on the firing line have one.

The gas mask was unknown in modern warfare. We did not have a single man in our entire military service who had given the gas mask any study or attention, or who was assigned to the work of studying it, or making preparations for the use of it. And yet today not only every soldier we have is supplied with one, but with the extra reserve masks necessary to protect them against the poisonous gases used by the enemy. And they also have the chemicals necessary to destroy the harmfulness of that gas, and which may be added to the efficiency of the gas mask so as to make the gas ineffective. (Applause.)

One of the most efficient military officers engaged in the Allied armies came to this country with one of the foreign missions. He was here six weeks and he told me he was anxious to get back to the firing line, because in this war methods were revolutionized so quickly that when he returned he expected to be entirely out-of-date in the warfare at the front and would have to take a course of instruction to get up-to-date. That is about the proposition we must deal with, and I gave this illustration so that we may have some appreciation of the tremendous task that faces the American people.

Anyone who is familiar with what has happened is not at all pessimistic. I have heard Senator Root say that there was more pessimism in Washington than in all of the United States put together; that men there seemed to have all of the bad feelings and were unable to

appreciate the good and wonderful things that had been accomplished.

Our country has undertaken this task upon this great and comprehensive scale that is significant of American genius and capacity. No one in this country is in fear of ultimate defeat. We know that mistakes will be made here and we know that reverses will be suffered abroad, but we know that the American people have been stirred to the very depth, and that the patriotic pulses of every man, woman and child are beating at the highest. We know that everything will be done, and no satisfaction will be considered until it is definitely known that not only will our enemy be defeated, but that our cause will prevail in the war as the American people intended it shall, and an end shall be forever to the menace of militarism throughout the entire world. (Applause.)

We have a great task before us. Not only are the men compelled to go abroad to make sacrifices, but those of us who remain here will be compelled to make sacrifices equally as great.

No man can expect to finish this war better off financially than when it began. He is not a patriot if he does. The Government is calling for money in sums unheard of in the history of the world. Our reputed National wealth is two hundred and forty billions of dollars, and it is estimated that the free income of the country, after the expenditure of the money necessary for the necessary maintenance of the country, is between twelve and fourteen billions annually. That means that not only must we contribute generously and liberally; it means that we must, everyone individually make sacrifices in order to pay the tremendous toll which will be demanded. But what is it to ask men who remain here, safe in the security of their homes, enjoying the blessing and the prosperity of this free land, to make the mere sacrifice of their wealth, when we are calling upon from two to five millions of the very flower of the youth of this country to go abroad and make perhaps the supreme sacrifice of their

lives. (Applause.) Some of them may come back here physical wrecks for the rest of their lives, but the American people have dedicated themselves to this contest as no other people in the history of the world in any contest. (Applause.)

We did not go into this war because of the insistence or of the orders of any Emperor, or any king or potentate. The American people by their own determination, and their own free will engaged in this contest, and with the help of the God of Nations they will dedicate their every life and all their wealth in order that success may come in this contest. (Applause.)

JUDGE GARY: One of the finest things I ever read was the utterance of a distinguished soldier, General Wood (applause), who after receiving word that an order had been made which seemed to the American public to be unjust was asked to state his opinion. He said: "I am a soldier; I obey orders; I salute the flag." (Applause.) With him closely associated for some time was another distinguished and highly respected man and soldier. I have the honor to introduce Major-General Edward T. Glenn. (Applause.)

MAJOR-GENERAL GLENN: Mr. Chairman, ladies and gentlemen of the Iron and Steel Institute. I came to this great metropolis from the State of Ohio (applause and cheers), where I have been for the last nine months charged with the responsible duty of training twenty-eight thousand men, one division, to perform their duty on the battle fields over there, and in the promotion of their interests, I gave these men instruction in target practice. I believe this to be one of the essentials of a soldier in which we can hope to claim superiority over all other soldiers of the world. During the past four weeks I have had to train in target practice men who had never handled a gun, and I purpose to make to you the surprising statement that not one, but many of these men, were so much exercised over having to use a rifle, a high-powered rifle, on the rifle range, that they asked

if it were not possible for them to be excused from this duty. In two weeks time I had over fourteen thousand men go through target practice, and each and every one of them fired more than 250 shells or bullets, and every single man who came back from that range came back an enthusiastic target man. (Applause.) I consider that a very remarkable record, if you can take men who have never fired a rifle, who actually have a physical fear of doing so—which is almost incredible to a man of my years, who has grown up in this country—and convert them into enthusiasts in that length of time.

Now, gentlemen, one of the greatest pleasures to me, here by accident—an accident over which I had no control—is that I have been allowed the privilege of meeting the iron and steel men of this country, because upon you as much, if not more than upon any other body of men in this world, rests the very great responsibility of enabling your army and the army of our Allies to secure that measure of success which we must secure if we are going to continue as a Republic in the enjoyment of the privileges to which we have been accustomed since our birth. It is an especially gratifying thing to me to find that our people, our manufacturers can now use occasionally the past tense, and frequently the present tense in speaking of their accomplishments, rather than what we expect to do in the future.

I know of nothing more gratifying to the soldier than to feel that the neck of the bottle, or our shipping, has been placed in such competent hands. (Applause.) I was much gratified to have Mr. Fitzgerald refer to the question of mistakes. Gentlemen, it is my belief that our mistakes, and they have been many, have been the direct moving cause of placing Mr. Charles M. Schwab at the head of the ship manufacturing program. (Applause.) We of the Army do not believe that there is any other man in the United States who can secure, and has secured to the United States one hundred per cent support of, not only the iron and steel industry, but of every other industry allied to it, of which he is making use.

Now, I want to turn to another phase of this, which, I think I may say is likewise economical. I refer to the situation which exists in Europe today, and discussing it purely from an economic standpoint, and I shall be brief.

I take it that each and all of you had kept in touch with the map of Europe. I do not presume that every man in this country keeps in close touch with the political aspects of Europe, as it has been our policy for at least a century not to become mixed up with European affairs. I do not believe that we would now be mixed up in it were it not for the fact that our very existence as a nation has caused us to undertake the job. (Applause.) At this particular time when our enemies are making the second tremendous drive, and when you read, as I did in the paper this evening, that the center is still being crowded back, it is time for us to stop and take note of what the real situation is, and what any turn—any unfortunate turn, as there is nothing in war that is absolutely a cinch—what an unfortunate turn may mean for us. I have noted that we have not thrown our reserves in or made a counter attack—and I do not pretend to possess any knowledge of the conditions that exist over there that are not open to you—but the fact remains that up to date, since this second drive has been commenced, while our reserves are there, or are supposed to be there according to the press, this drive has not yet been stopped. I believe it will be stopped and I hope it will be my good fortune with my Ohio men to get there and help to stop it. (Applause and cheers.) But that relates very largely to the military.

Now, I am going to invite your attention, and I am going to ask each of you to make a careful study of it to the map of Europe—in other words, what the conditions are today. If you will take the trouble of examining this map, and note the part of Europe that is today over-run by Germany or is being over-run and subjected to the domination of Germany, you will find that there is a

comparatively small fringe on the outer side, which is actually under the control of the United Allies. Now, then, I am going to ask you in that connection to consider what this means to Europe and to the rest of the world, including the United States. Our enemy, Germany, has been fighting for at least fifty years for a route to India. And why? First, because she needs a market, and it is generally spoken of by all people whom I have read, or whom I have studied, that the nation which controls the markets of India incidentally controls the commerce of the world. Be that as it may, Germany has been struggling for that, and she now controls a route to India via the Dardanelles, except that England is at Bagdad with her troops. Not only does she control this route to India, but she controls two perfectly separate routes to India via the Ukraine and via the Black Sea and the Danube. And she will control another route to India or Asia, which is the same thing, via the Trans-Siberian Railroad—and so far as my study and investigation goes, Siberia is today the most promising part of Russia's possession. You can understand as well as I what this means to Germany. She will find there copper and minerals of all kinds, including platinum, and the only real platinum mines in the world. But above all, gentlemen, she will control a very much more vital and important element to us, and one that we must at all hazards prevent her from controlling, namely the cheap labor from India and Asia generally. If Germany, with her tremendous ability in the manufacturing line, ever gets possession of even Russia and the cheap labor of Russia, and particularly if she gets control of the cheap labor of India and Asia, and with Japan also in control of similar labor, the result to this country is bound to be dangerous beyond expression. It is a rule of trade that any and every man engaged—I believe I am stating it correctly—that any and every man engaged in commerce will buy where he can get the best for the least money; and there is nothing manufactured that we can manufacture in competition

with Germany with labor which would then be available to her at from six to twenty-five cents a day.

Now, gentlemen, this to my mind is the great problem that this country has and must necessarily study in connection with this war. I have not heard it presented for the consideration of anyone. I am delighted to see that the press of our country is taking up the cause of Russia, but I have yet to see any paper in this country announcing the ultimate result, the logical result, upon our country of our permitting Germany to control that market and those men. She has not, it is true, reduced Russia, and she may find great difficulty in digesting what she has undertaken; but the fact remains that she is practically controlling the best part of Russia, where is produced copper in abundance, of which she is seriously in need, and iron, coal and oil. And with this alone, and with her route to India and cheap labor, the ultimate result is bound to be, as I see it, full of danger to us and the world.

Now, gentlemen, I am very happy indeed to have had the opportunity of expressing thus briefly to you what I consider the great problem in connection with this war, in so far as it affects us. I believe that this danger should be appreciated by every laboring man in this country. I believe it should be pointed out to him so that he may know or formulate his own opinion. And I believe that, if it is brought to him straight from the shoulder, the laboring man of this country will enable the manufacturers of this country to provide any and everything necessary to prevent any such catastrophe. (Applause.)

JUDGE GARY: I will say we appreciate the presence of General Glenn and we appreciate the meaning of the words he has uttered. They are solemn, sincere and of importance at this time.

We are now going to listen for a few moments to Dr. Darlington, who will present his word to the meeting. His subject, I believe is in both words and pictures. Dr. Darlington. (Applause.)

PROLONGING THE LIVES OF BUSY MEN

THOMAS DARLINGTON, M.D.

Secretary of the Welfare Committee
American Iron and Steel Institute, New York

For some years those engaged in the production of iron and steel have given much consideration to the health of those who labor in that industry. More particularly has this care been given to the workers who by manual labor in mine and mill help to turn out the great products of iron and steel upon which our modern mode of life depends, for there is no phase of manufacturing or occupation which does not more or less depend upon that industry.

You have placed as a first consideration, above everything else, the lives and health of those employed under your care. The workman has been surrounded with everything to make his task less arduous and his environment more healthful; and this service has been extended not only to himself but also to his family and his household. Everything, from shower baths to playgrounds and club houses, has been his without asking! Every means known to science has been used to prevent accidents; and if an accident should occur, everything that money and science can do for the recovery of the injured workman has been and is being done. All this has been justified on the theory that it is for good citizenship, and that as efficiency depends on health it is good business and there is a proper return to the stockholder.

But while all this has been going on, we have given little concerted attention to the health of those leaders themselves who watch over these great industrial establishments, who arrange for the finances of enormous projects, who must look daily at cost sheets and assume a thousand and one responsibilities known only to them-

selves. In the past few years some of these captains of industry have been removed by death. To my mind this has occurred earlier than was necessary.

The man who mines the ore and he who watches the furnace or straightens the bars are most profitable servants; but shall we not also consider him who ascertains the level where the cars may carry the ore, or him who directs and brings uniformity and order that mills may work in unison, or him who finds a market for the products? The hand is a most necessary member of the body, but could it succeed well without the eye?

So we come to-night to take up the question of the conservation of the health and lives of the chairmen of boards of directors, the presidents, vice-presidents, general managers of companies, the sales managers and engineers. What shall we do for these? Many of them, already pushed to the limit of their powers, whose hours of labor cannot be fixed by a day's work, and whose responsibilities are never ending—what care does the industry owe to them?

You are the men I am talking about. What care do you owe to yourselves? It is to this important theme that I invite your attention for a few minutes. Especially do I direct my remarks to those who have passed the meridian and reached the afternoon of life. Not only is it in this period that the greater dangers lie, but it is also usually in this period that one's best work is accomplished. It is related of Moses that his life was divided into three parts and that he lived to be one hundred and twenty years of age and that "*his eye was not dim, nor his natural force abated.*" He might have lived longer had he not disobeyed the commands of his Maker, which he himself recorded. The best work of his life was done in the latter half, after the age of sixty. And this is true of many others, that their greatest work has been when past middle life.

HOW SHALL WE DECIDE?

How shall we decide what is the best method of conserving the health and of prolonging life when approaching or past the age of fifty? We may learn much in several ways toward the solution of this problem.

First, we may take up the causes of illness and death at the late age periods and consider how to avoid them.

Second, we may apply our newer knowledge of physiology or the recent discoveries in medicine to every-day living conditions.

Third, by observation of the mode of living of those who have reached a ripe old age.

Of the first, the causes of illness at this period, we find disturbances of the circulation of the blood; disorders due to bacteria; some due to nutrition, that has to do with digestion, assimilation and excretion of food products; others due to progressive tissue changes. If we study the records of death of the different age periods, after middle life, especially between the ages of fifty and seventy-five years in the order of their importance, we find that diseases of the circulatory system, that is, organic diseases of the heart and diseases of the arteries (arterio-sclerosis) come first; that certain diseases of the respiratory system—pneumonia and tuberculosis, taken together, come second, with Bright's disease of the kidneys a close third. Following these are cancer, diseases of the digestive system, including diabetes, and next, accidents.

It will readily be seen that in the limited time allotted for this paper it is possible to take up only a few of the more important ailments which beset one at this period of life.

ARTERIO-SCLEROSIS.

Arterio-sclerosis is the most common cause of death after middle life. We may almost say, the natural cause

of death. It has been well said that "a man is as old as his arteries." What is arterio-sclerosis? To understand this we must know something of the anatomy and physiology of the circulation of the blood. The blood is propelled through the vessels by the contractions of the heart. It flows through the large arteries into smaller subdivisions, the smallest called capillaries, and from these into the veins to be returned to the heart. It is our system of plumbing. A central pump and a closed system of tubes; and endless circulation, with the heart beating 70 to 80 times a minute, never ceasing from before birth until death. Continuous work. Like machinery, used properly it becomes better with work, running smoothly with less friction. But if forced beyond a certain speed, it wears quickly and the machinery is injured.

In general, arteries are tubes composed of several layers or coats. There are an inside lining, then a thin elastic layer, then a muscular coat and finally an outside covering. The middle coat, composed of muscle, is the thickest. Arterio-sclerosis is an inflamed or diseased condition of the walls of the arteries, characterized by an increase or a decrease in the thickness of the walls. It is the middle or muscular coat that principally shows disease changes. There is a weakening or thickening of the middle layers caused by mechanical or poisonous agencies. If much work should be put upon the heart and circulation this coat grows thicker so that the lumen or opening in the tube becomes smaller; and because of such thickness the walls are more rigid. Even in early life we may find great changes in this coat in those who work hard or in athletes. At the age of 35 arteries begin to show changes which are quite marked at 50. Naturally the pumping of the heart makes pressure upon the tubes. There is a certain resistance offered. This is blood pressure. We notice this pressure when an artery is cut; the blood spurts. The walls of arteries are elastic, and this elastic tissue and muscular wall prevents an artery from rupturing. Should the pressure become great, as

in severe labor or strain, the walls grow thicker to meet the demand. It is a compensatory arrangement on the part of nature. She adapts herself to circumstances, thickening the walls of an artery to resist strain of hard work, and thinning or undergoing fatty degeneration with lessened exercise in those whose habits change to sedentary.

So a person of sedentary habits must not suddenly indulge in severe exercise. The change should be gradual and then maintained in temperance.

The heart also attempts to adjust itself to circumstances and conditions.

In certain disturbed conditions of the building up or breaking down and waste process of the body, when there have been disease changes in the arteries, lime may be deposited in the arterial wall, making the vessels hard like pipe-stems, so that they no longer expand and contract as they should. This interferes with the functions of the various organs, raising the blood pressure so that a vessel may burst. When this happens in the brain it is called apoplexy.

The muscle surrounding an artery is not under the control of the will. It is termed involuntary. It is controlled by a system of nerves, which are under the influence of the secretions of certain glands in the body, largely a gland attached to the capsule of the kidney and the thyroid gland in the neck. If we are frightened or excited, a powerful chemical substance called adrenalin is thrown out. This contracts the muscles of the arteries and lessens their caliber, producing a higher pressure and blanching of the face. On the other hand a blush indicates other secretion with an opposite effect. In other words, our mental attitude has much to do with our circulation. Anger, worry, fright—all affect the heart beat. So among the chief factors that influence blood pressure is the mental.

Another cause of thickening and degeneration of arteries is from toxic or poisonous substances circulating in

the blood. Many poisons are formed by bacteria. Some disease germs themselves circulate in the blood; sometimes the toxins which they make. These poisons produce inflammation in the wall of the arteries and affect the blood pressure.

BACTERIA AND THEIR POISONS.

We find that much disease is due to bacterial invasion of the body; not only disease of the walls of the arteries, but of the valves of the heart, even changes in the blood itself, for anemia is due largely to bacteria or to toxins. Pneumonia, tuberculosis and influenza are bacterial diseases. Bright's disease is due to toxins or bacterial invasion of the kidneys, as also are ulcers of the stomach and duodenum. And so originates most of the serious disease of the various organs.

How do these germs or their poisonous products get into the system? Most infection occurs through the mouth or nose. How? The bacteria get into the mouth from dust, from unclean hands and from food contaminated in handling or by flies, and they may find their way to the lungs or the alimentary canal. So they or their toxins may be absorbed. They may be absorbed from the intestinal canal, or from the nose, throat or tonsils, or the sinuses, or from some focus of infection about the teeth.

Until recently many physicians regarded the tonsils as the greatest sources of such disease; while others, like Metchnikoff, believed the large intestine to be the principal cause. Investigation in the last thirty years, recently confirmed by *x-ray* photographs, shows that diseased conditions of the mouth and teeth are responsible for much systemic disease and for poisons in the circulatory system.

TEETH.

Good teeth play a part in personal appearance, enunciation, and in the comminution of food. In this latter process the mingling of the saliva with food aids diges-

tion. But the mouth contains many bacteria, and teeth decay, and an abscess or diseased or dead bone may be the result. Absorption of poisons from such conditions often seriously affects the whole body. Some diseases, until quite recently obscure in their origin, we now know can arise from such focus of infection. Many cases of rheumatism, of neuralgia, and other body pains, or inflammation of almost any organ, can come from this source—of the arteries, of the lining of the heart (which affects the valves), or of the gall bladder, or of the appendix. A recently published list in a medical journal gives more than thirty diseases which may derive their origin from such a condition, too long a list to enumerate.

As I have said, the mouth contains many varieties of bacteria. Even though the teeth do not decay and the bacteria or their toxins are not directly absorbed in the system, they may pass into the stomach with food and may do harm in the intestinal tract by spoiling the food or making poisons, producing a condition commonly known as “auto-intoxication.” Nothing is of more importance than to get rid of these points of infection. The teeth should be *x*-rayed and old roots and dead teeth removed. Keep the teeth well brushed, and pay strict attention to mouth hygiene. Connected also with bad conditions in the mouth we frequently find anemia.

ANEMIA.

By this I do not mean a lack of blood in any particular part of the body, but an alteration in the blood itself, generally spoken of as poverty of the blood—a reduction in the quantity or number of red blood cells, or of their most important part, the pigment material. As this red material carries the oxygen to the tissues, extra work is put upon the smaller number of corpuscles, and an anemic person is easily fatigued. Upon slight exertion he is apt to have palpitation of the heart, become short of breath. He also has lessened resistance to infectious disease. Anemia may come from lack of blood formation,

or from loss of blood, or from poisons in the blood, usually those made by bacteria. Where there is constant absorption of toxic materials from some focus of infection such as an abscess at the root of a tooth, there may be extensive destruction of the red blood corpuscles. The blood may be reduced from five million to a million corpuscles, and a person so affected may be entirely unfitted for work. In this condition degenerative changes frequently take place in the heart, liver and kidneys. When due to such a cause, if we get rid of our point of infection, we recover from the anemia unless it has gone too far.

BRIGHT'S DISEASE.

Disease of the arteries is closely related to diseases of various other organs of the body. It must of necessity be so. For the different organs are well supplied with blood vessels, and if these are changed it must change the supply of blood to the organs. Particularly is this true of the kidneys, and we find Bright's disease associated with disease of the arteries. We may even be able to see some of these changes by an examination of the back of the eye.

PNEUMONIA AND TUBERCULOSIS.

What of the two main diseases of the lungs—pneumonia and tuberculosis? Both are due to invasion of bacteria in the system. Both are communicable by people. The germs are very prevalent. They are found in most people's mouths and noses in certain seasons of the year. And either through dust of dried sputum, or chiefly from the spray of saliva, both inwardly and outwardly, which people make when talking, the bacteria get into the lungs.

There are several things of importance in the prevention of this disease. Sometimes the common "cold" which people have is due to some form of bacteria that makes pneumonia; and if we come into contact with

people having a discharge from the nose made by these germs, should the resistance of our body be low, one is apt to take pneumonia. So one should avoid contact with people having "colds"; for, though they may not have pneumonia, they may be carriers of the germs of that disease. The mouth and nose should be kept clean and in a hygienic condition, and the body must be kept or raised to the resisting point. Remember that pneumonia is readily acquired from others, provided resistance has been lowered by exposure to cold, especially if one has not eaten proper food or has become fatigued from overwork, from lack of sleep, or lack of proper movement from the bowels. It is also possible that this disease may be acquired in the blood stream from a point of infection. The same may be said of tuberculosis.

In regard to tuberculosis, perhaps the most important point that I can bring to you is the early recognition of the disease. While it is especially true of tuberculosis, a disease which it is comparatively easy to cure if early recognized, this may also be said of all other diseases. For all diseases have their beginnings and many of the more serious give repeated warnings. Few persons are attacked without due notice. We should heed these early warnings.

PHYSICAL EXAMINATION.

In recent years much has been written about the physical examination of workmen, and there has been much favorable discussion on the subject by those that employ labor. If there is any advantage in this to the employee, there is just as much advantage to the employer, if he also be examined. The employer needs strength and endurance as well as the employee. Moreover, as physical health affects one's mental attitude, it is perhaps of more importance to the work that the employer should have good health than that any single employee have it. All the arguments that apply to the one apply also to the other. Keep in touch with your physi-

cian. It is easier for him to prevent disease than to repair its results.

CANCER.

We have progressed but little in our knowledge of the cause of cancer. For many years but one fact relating to its origin has been known, and that is the influence of chronic irritation. Fully thirty per cent. of the cancers which occur in man are in the stomach. Why should this be so in man and not in the lower animals?

In a recent paper upon this subject by Dr. William J. Mayo of Minnesota, he advances a theory worthy of consideration, that cancer of the stomach is due to hot food and drinks which cause a constant irritation. He calls attention to the infrequency of cancer in animals and primitive man, noting that these take their food and drink cold, whereas civilized man frequently swallows his food too hot, much hotter than can be borne comfortably in the mouth.

He gives as an instance the frequency of cancer of the throat in Chinese men, who are served while the rice is hot, and the rarity of cancer in the women who eat at second table when the rice is cold. He also calls attention to smoker's cancer of the lip, confined to men, and to the kangi burn cancer of the abdomen of Kasimir natives who carry a clay charcoal burner across the lower abdomen when they go into the mountains.

Heat may not be the cause of all cases—it may be of but few—but this knowledge should at least lead us to eat slowly and not bolt hot foods or fluids.

OVER-EATING.

Of the diseases of the digestive system, the endeavor to satisfy the palate, as well as hunger, leads many persons to eat too much. Certain foods not in themselves poisonous may produce substances that raise the blood pressure, especially if these foods should be taken in excess. Constant overloading of the stomach with rich

food causes overwork of the vessels connected with the organs of digestion, and as a consequence these organs suffer degenerative changes which ultimately limit their functions. In many cases, probably one-half the amount of food eaten would suffice. And while we habitually eat too much, we drink too little water.

Too much food leads to obesity, and obesity is a strain upon the heart, partly because the heart is pushed out of place, partly because one cannot breathe deeply from fat in the abdominal cavity, and partly because of enlarged arteries and veins and of more vessels to fill. Are you too stout? It is easy to get thin. It is principally a question of diet and exercise. Give up bread, potatoes and sugar, and take exercise.

Some business men are in the habit of taking but two meals a days. Going without luncheon usually puts too much strain on the digestive organs at dinner. It is better to eat lightly at noon and not too heavily at night, and thus to distribute the load. Remember that when people are ill, good results are obtained by eating often and lightly.

We are creatures of habit; so it is essential to eat at the same hours daily. The secretion of the gastric juice is produced particularly by the sense of taste and flavor of food. The service of the food must be pleasant, both to the eye and to the palate.

As far back as Lucretius it was known that what may be meat to some may be poison to others. To most people strawberries are delicious and wholesome; to some they are poison, as shown by the rash produced upon the skin. If one has such an idiosyncrasy in regard to any food, he should give that fact due attention. In deciding upon a course of action, one should consult a physician. Even a so-called "balanced ration" may not contain vitamins.

A disturbed state of the stomach produces irritability and temper, and irritability and temper produce a disturbed state of the stomach. Thus is induced a

vicious circle, especially in those who cannot or do not exercise self-control.

INFLUENCE OF THE DUCTLESS GLANDS.

I referred briefly to the secretions of certain glands in the body, the adrenals and the thyroid. There are several others, each, as far as we know, having a specific effect upon the body.

Modern research shows that these glands exert a marvelous influence upon the physical life and upon mental development. They are the agencies that largely govern our conditions as to healthy mental and physical activity.

As an engine responds to the governor upon it, the governor responding to the pressure of steam, increasing the speed or diminishing it, so the wonderful human machine responds to the secretions of its ductless glands, as the brain and the emotions activate them.

As shown by Cannon and by Crile, with emotional excitement, such as fear or horror, adrenalin and probably other secretions are thrown out. As a result, the blood vessels contract, the skin becomes pale, the mouth dry so that the tongue cleaves to the roof, the hairs rise, the lips twitch and the muscles tremble, there is rapid beating of the heart, with hurried respiration and dilated pupils. There is a mobilization of energy-giving compounds, and the organs that do not immediately increase motor efficiency, such as the stomach, stop work. And not only fear, but anger, worry, jealousy, envy, grief and disappointment all influence such secretions, increasing, for the moment, material in the cells with a later exhaustion and deterioration; and the body is fatigued just as in severe labor or excessive physical exercise. Chronic emotional stimulation exhausts the brain and may cause disease of the circulation, indigestion and diabetes.

It has been truthfully said that when stocks go down in New York, diabetes, kidney and heart disease go up. On the other hand, we have long known that joy, love,

laughter and sleep have the opposite effect, and that with a cheerful mind even the sight of appetizing food affects favorably the secretions of saliva and the gastric juice.

We must be very careful to avoid all agencies that give rise to unusual activity of these glands. There can be no question but that one's mental attitude determines largely these secretions, and consequently bodily health.

PERIOD OF REST.

In studies made of fatigue, by careful measurement of output with groups of workers in munition factories, it has been found that periods of rest increase considerably the total production and lessen the amount of spoiled work. The recovery of working power during a sufficiently long luncheon period is generally striking. It is an indication of the beneficial effects of a resting period and food. If it be true that periods of rest are of great benefit to those engaged in manual labor, how much more is such rest needed for the brain-worker, the head of a company. Particularly is this true of the lunch hour. More business is proportionately transacted in clubs at lunch time than in any other hour of the day. Yet this is the time more necessary to rest than any other hour. This, with reading the newspaper at the breakfast table, is, to my mind, an injurious practice. With the mind on business, one does not think much of eating and eats rapidly, and, therefore, eats too much. It is particularly injurious because the food is not eaten with a relish, for the mind is concentrated upon things other than food. Eating should be a recreation and rest, not business, and no mental work should be done just before, during, or after a meal.

Because, however, the majority eat too much and there is great danger from over-feeding, one should not go to the other extreme of under-feeding, for this means loss of energy, loss of resistance, and one more readily becomes the victim of infectious disease.

Ofttimes diseased conditions are not curable, but they can be ameliorated. It generally depends upon the willingness to modify one's mode of living.

"Man does not die, he kills himself," said the Roman philosopher, Seneca. One's habits largely determine the span of life. We are not at this time concerned with the early period of life, nor how early living is calculated to secure a long life. That is something for your children's children. How may we live, with such infirmities as we have, and not increase these nor acquire more? How may we do our daily tasks easily and normally, and not have the modern stress and strain of life shorten the period of existence? How may we lengthen it? What habits must we acquire?

EXERCISE.

First of all comes exercise, which causes the blood to move more rapidly through the body, especially to the lungs, where deeper breaths oxidize effete materials. What kind of exercise? Outdoor, if possible, for there we have the advantage of fresh air and sunlight; and wonderful, indeed, have been the cures from fresh air. Walking, golf, tennis, horseback riding, rowing, swimming and gardening. If one cannot do any of these things, cannot exercise in the open, then there are exercises to be done in the house. A physician should determine the amount and kind of exercise, and the time allowed, and if golf, the number of holes to be played. Exercise should be taken regularly; not simply on Saturdays, when it may easily be in excess.

SLEEP.

With proper exercise one sleeps better, partly from healthy fatigue and partly from better digestion. Said Ecclesiastes, "*The sleep of a laboring man is sweet, whether he eat little or much; but the abundance of the rich will not suffer him to sleep.*" Sleep is the time when men renew their mental and physical strength, when the

body recuperates and when toxins are eliminated. A man may live a month without food, but he succumbs quickly if he lose his sleep. Especially do I direct your attention to travel at night. It may be imperative; but when not necessary it should be avoided. Sleep on a train is not as refreshing as in a good hotel; especially does one miss the morning bath and the toilet arrangements. Arriving at midnight is better than arriving in the morning.

When possible or convenient in seasonable weather, it is best to sleep out-of-doors, that is, on a porch arranged for the purpose; but if this be impossible, at least the windows of the bedroom should be opened wide. Even in winter weather one can always be warm by the use of a quilt or down coverlet over blankets. Fresh air favors efficiency and helps to avoid disease.

DRINK WATER.

We have already dwelt upon the subject of drinking water at other times in connection with water supplies of the mills, so that it seems almost superfluous to take it up here. To drink water is necessary for the health. It is an ingredient of the body entering into the substance of all the tissues. Taken with food, it aids digestion. One of the most common faults in eating is to neglect to take sufficient water with the meals. Besides carrying food in solution to the tissues, water carries away waste—the waste from the production of heat and energy. If such products are not rapidly eliminated they have a fatiguing effect and working power is impaired. The good of exercise is often undone by failure to drink water. Water aids in secretion. Many membranes must be kept moist to avoid friction. One of its most important functions is to regulate the degree of temperature of the body. It also acts as a distributor of heat. The average daily amount lost from the adult body is five pints. This must be taken daily, allowing a pint and a half of water to represent the average water

content of the food eaten. The remainder, three and one-half pints (about seven glasses), must be taken in drink in some form. These figures vary with weather and exercise. To obtain the necessary amount, it is essential to drink water between meals, a matter usually neglected. There is only one way for the busy man; his secretary or stenographer must bring him a glass of water at certain hours, morning and afternoon, no matter what conference is on. He should also be reminded when it is time for luncheon.

SHOWER BATHS.

Not only internally, but also externally, water plays a part in lessening fatigue. The therapeutic use of the bath is as old as medicine itself. The capacity of water for heat makes it valuable for use in extracting or applying heat.

The skin covers a network of blood vessels and nerves. The application of cold causes the vessels to contract, and heat causes them to dilate. Such stimulation of the skin affects not only the surface of the body, but the nerves and blood vessels of the whole system. Experiments upon the human body, recorded on a machine made for that purpose, have proven that cold applications increase resistance to fatigue, and that they restore efficiency for work to a muscle already fatigued. The effect of such a bath is to produce a redistribution of blood in the body. In a properly arranged shower the striking drops stimulate the skin and the heart is also stimulated. There is an increase in the production of animal heat. It lessens the secretion of the skin but increases the internal secretions. The blood shows a change in the number of corpuscles.

Thus acting through the skin, water affects secretion, excretion and the heat regulating function. Shower baths may, therefore, be used to eliminate more rapidly the products of waste, to promote secretion, to relieve fatigue and to restore the normal functions of the various

organs of the body, to restore body temperature to the normal, and to produce a redistribution of the blood when there is congestion in any one part of the body. It is a remedy of great value in the prevention of arteriosclerosis and in certain diseases of the heart. In taking a cold shower it is usually best to commence with warm water and gradually reduce the temperature until shivering is produced.

As one advances in life there should be moderation in all things—not too much to eat or drink, not too much exercise, moderation in work, moderation in pleasure. If we are not self-indulgent we may calmly face the vicissitudes of this life.

BODILY COMFORT.

We must also regard bodily comfort. If one should have a mole or a wart which may be irritable and painful, and is unconsciously handled, have it removed; for any chronic point of irritation is apt to lead later to malignant disease. Is your chair comfortable? Is it soft, so that pressure may not produce pain or sciatica, or stiffness of the limbs? Is the room properly ventilated, so that no draft comes upon your body? Does the light fall on your desk properly? Are your shoes easy and well fitted, or do they tend to make corns and bunions and ingrowing nails? Pains in distant parts of the body may come from an ill-fitting shoe, especially if the bones of the foot are in any way displaced.

There is, perhaps, no more important factor in comfort and personal hygiene than the clothing, and of late a great change has taken place in our ideas upon this one subject. The change in women's clothing in the last fifteen years has been very great. No longer do her dresses sweep the sidewalk. No longer can we say:

Her feet beneath her petticoat,
Like little mice, stole in and out,

for she wears no petticoat. As a consequence of getting

rid of heavy flannels and superfluous clothing, women's health has improved greatly. The change in men's clothing has not been so marked. Body temperature is partly controlled by means of clothing, and it is my personal opinion that at no time should anyone wear undergarments made of flannel. Tight collars and tight clothing interfere with the circulation and in addition are uncomfortable.

Many body pains and much discomfort not infrequently arise from a sagging of the abdomen, pulling upon the stomach, kidneys or other organs. This may occur from weakened abdominal muscles or from an accumulation of fat. In such a condition a belt or some other such contrivance that supports the abdominal wall gives great relief.

The health of the body cannot be maintained unless the bowels perform their functions regularly and sufficiently. This is largely a matter of diet and habit.

At no time in our existence, no matter what age, should life seem burdensome. Even until old age, persons may be normal. By that we mean that all parts of the body move and perform their functions easily and unconsciously and pleasurably. Even in old age, people may dispense with the usual inconveniences that attend that state, provided, of course, they have sufficient income for their needs; not as in Gray's *Elegy*, where

Chill Penury repressed their noble rage,
And froze the genial current of the soul.

Cicero wrote that a certain prominent Roman remarked that he "had no reason to complain of life." And this must be the attitude for those who would live long. There are many people who seem to regard life as a fit of sickness, or as a hymn says, "a vale of tears" to be gotten through as soon as possible. If instead, we can find continual happiness, see everything from the optimist's point of view, many of our problems that relate to health would be solved. And we may find much

of this happiness, like the Creator of all things, in the creations we ourselves make, in our daily work.

The practice of these things which I have mentioned, tends not only toward prolonging life, but to making one a more useful citizen, more accurate and quicker in thought. It is useless to prolong life unless one becomes happier and more useful.

And if these things be also practised by the workmen who come under your care, they too, will profit in like manner. Example is a great teacher.

HABITS OF THOSE WHO HAVE LIVED TO BE OLD.

Those who like Weber, observe closely and study the manner of living of persons who have reached the century mark, find confirmation of the facts that I have presented to you. With but few exceptions, certain things have contributed to their long lives. First and foremost is heredity, a strong line of ancestors who have lived long. In this respect, however, there have been some notable exceptions for the earlier period of life. Some who have lived long were not born strong, nor were they men of vigorous ancestry. Yet they reached the goal, for we may increase or decrease inherited resistance. We find, as a rule, that they were temperate in all things, especially in restricting their food; that they rose early and lived in the open; and that they all worked and led active lives. Few indeed have been wealthy. There have always been things that they wanted, but they were contented with such things as they had; and though they had no luxuries, they were cheerful and of happy dispositions.

This paper has been written because of the urgency of its need. How could the United States spare the honored President of this Institute and the Chairman of the Board of Directors of the great Steel Corporation, or its President? How could the country spare that great leader of industry who has consented to guide the building of our ships? Their lives belong now not to

themselves or their families, but to the country. Or could the nation spare any other of these leaders in this great industry? No, not one man within the sound of my voice could be spared. Your country needs you. I beg of you that you conserve your lives for the good of the nation, take care of your health as a patriotic duty. The present need is great. Then "*let us lay aside . . . the sin (against health) which doth so easily beset us,*" and heed the following ten health commandments:

TEN HEALTH COMMANDMENTS.

1. Keep your mouth closed when breathing, also when angry.

2. Drink cool water with your meals, also between them.

3. Bathe daily; a shower, if possible.

4. Eat slowly, this leads to eating sparingly. Make your meal a ceremonial pleasure.

5. Never read or transact any business while eating.

6. Exercise daily and breathe deeply while so doing, but avoid over-exertion and never eat when fatigued.

7. Work ten hours, sleep eight, and the balance for recreation and meals. Always rest on Sunday.

8. Ever keep a contented mind. Equanimity means longevity.

9. Neglect no portion of the body. Employ a physician to examine you at regular intervals and so watch for the beginnings of disease and build up resistance, and pay some attention to his opinion and direction.

10. Moderation in all things. Even virtue in excess may become vice.

Let me close with a few lines by Robert Browning:

Grow old along with me!
The best is yet to be,
The last of life, for which the first was made;
Our times are in His hand
Who saith, "A whole I planned,
Youth shows but half; trust God: see all nor be afraid."

PARTICIPANTS—MAY MEETING

(Each star indicates a guest)

A

Abbott, Franklin E.
 *Abbott, Gordon W.
 Abbott, W. H.
 *Abbott, W. R.
 *Abell, Henry H.
 *Ackley, John W.
 *Adams, C. A.
 *Adams, F.
 Agnew, J. D.
 Ahlbrandt, G. F.
 Ahles, R. L.
 Akin, Thomas R.
 Alder, T. P.
 Alderdice, G. F.
 *Alford, W. T.
 Allen, Edwin M.
 Allen, John N.
 Allen, J. P.
 Alley, James C.
 Altemus, C. L.
 Amaden, E. A.
 Anderson, Brooke
 *Anderson, F. C.
 Anderson, Nils
 Andrews, M.
 *Anson, S. M.
 *Appleton, A. I.
 *Armsby, George N.
 Armstrong, V. C.
 Assmann, F. A.
 *Atkinson, Lloyd H.
 *Austin, Chellis A.
 *Austin, Walter F.
 *Avery, T. M.

B

Baackes, Frank
 Backert, A. O.
 *Baer, A. P.
 Bailey, George T.
 Bailey, R. M.
 Bailey, William M.
 Baily, T. F.
 Baird, D. B.
 Baird, Frank B.
 Baker, E. D.
 Baldrige, W. H.
 Baldwin, H. G.
 Baldwin, L. S.
 Baldwin, R. L.
 *Ballard, H. F.
 *Balliett, B. J.
 Balsinger, W. R.
 Baltzell, Will H.

*Barber, E. J.
 Barnes, C. A.
 Barnes, Edwin F.
 *Barnhurst, H. G.
 *Barren, C. W.
 Barrett, J. C.
 Barrows, W. A.
 *Bartholomew, J. B.
 *Bateman, James G.
 *Bateman, W. H. S.
 Bates, J. Ross
 *Bauer, Charles J.
 *Bauer, H. E.
 *Baylies, F. N.
 Beale, A. H.
 Beale, Harry S.
 *Bean, Henry Willard
 Beaumont, George H.
 Beck, J. J.
 Becker, J.
 *Becker, Luther
 Beegle, F. N.
 Bell, John E.
 *Bell, Walter E.
 Belsterling, C. S.
 Bennett, D. P.
 Bennett, William H.
 Bent, Quincy
 Bentley, F. T.
 *Benton, Andrew A.
 *Benton, Arthur H.
 Bergquist, I. G.
 Bertie, C. E.
 Bigelow, F. A.
 Biggert, C. F.
 Billard, J. G.
 Bindley, E. H.
 Bindley, John
 *Birge, Walter W.
 Birney, E. H.
 *Bitting, William S.
 *Black, H. F.
 Blake, O. P.
 Blakeley, Geo. H.
 Block, L. E.
 *Blowers, William B.
 *Bollinger, E. H.
 Bonner, James B.
 Booth, C. H.
 Booth, Charles M.
 Booth, Lloyd
 Borie, A. E.
 Boutwell, Roland H.
 Boutwell, Roswell M.
 Bradford, C. C.
 Bradley, W. J.

*Bragg, A. H.
 Braid, A. F.
 Brainard, J. W.
 Braine, L. F.
 Braman, H. S.
 *Brandler, C. F.
 Brassert, H. A.
 Breeden, William
 *Brevoort, W. H.
 Brion, A. E.
 *Brion, Lester
 Brooke, Robert E.
 Brooks, J. J.
 *Brooks, Paul
 *Brosseau, A. J.
 *Brown, Robert C.
 Brueckel, Lee D.
 Brunke, F. C.
 Buck, C. A.
 Buckley, Samuel S.
 Budd, R. B.
 Buek, C. E.
 Buffington, E.
 *Bumsted, William G.
 Burd, F. J.
 Burden, James A.
 Burdick, Julian
 *Burgess, Ward M.
 *Burke, Charles H.
 Burt, D. A.
 Bush, D. Fairfax
 Butler, Gilbert
 Butler, Joseph G., Jr.
 *Butt, Howard
 *Byrne, Joseph M.

C

*Caldwell, W. A.
 Camp, J. M.
 Campbell, J. A.
 Campbell, L. J.
 Canda, Ferdinand E.
 Carhart, Perry E.
 *Carlisle, L. H.
 Carnahan, R. B.
 Carney, F. D.
 *Carpenter, C. Hunter
 *Carpenter, W. T. C.
 Carr, Richard B.
 *Carrier, S. C.
 Carrigan, Andrew
 *Carroll, A. W.
 *Carroll, S. C.
 Carruthers, J. G.
 Carse, David B.

- Carse, Henry R.
 *Cary, Walter
 Champion, D. J.
 Childs, W. H.
 Christ, E. W.
 Christian, A. W.
 *Clarey, Northrup
 *Clark, E. W.
 Clark, Edward F.
 Clark, R. W.
 *Clark, Raymond S.
 Clarke, E. A. S.
 *Clephane, Malcolm W.
 Close, C. L.
 Cluff, Charles C.
 Clyde, W. G.
 Coey, Stewart C.
 Coffin, Wm. C.
 Cohen, Fred W.
 *Cohen, Theodore
 Colby, Albert Ladd
 Colladay, Frank H.
 Collord, George L.
 *Cone, John J.
 *Conheim, R. J.
 *Connor, E. H.
 Connors, G. W.
 *Conover, Samuel S.
 Cook, Harry H.
 Cook, Howard
 Cook, J. Edgar
 Cornelius, Henry R.
 *Cowley, C. O'C.
 *Cox, F. G.
 Cox, W. Rowland
 Crabtree, F.
 *Crane, Frank
 Crawford, E. R.
 Crockard, Frank H.
 Crook, Alfred
 *Crotty, M. J.
 *Crowell, Frank G.
 *Cunningham, Alex.
- D
- Daft, Andrew C.
 Dalton, H. G.
 Dalton, William
 Damerel, George
 Danforth, Arthur E.
 *Darlington, Thomas
 Davey, W. H.
 Davies, Geo. C.
 Davis, Arthur L.
 Davis, Charles C.
 Davis, Henry J.
 Davis, Pierpont
 Davis, Roy H.
 Davis, S. A.
 *Davis, Samuel
 Deericks, Joseph G.
 *Decker, F. N.
- E
- Dennis, M. S.
 Dette, William
 Devens, Henry F.
 Devens, Richard
 Devlin, Thomas
 *DeWyckoff, Joseph
 *Deyerle, O. M.
 *Dickey, H. C.
 Dickey, W. C.
 *Dickson, A. Morris
 Dickson, William B.
 Diehl, A. N.
 *Diescher, Samuel E.
 *Dimick, H. V.
 Dimmick, R. B.
 Dinkey, Charles E.
 *Dinsmore, T. H.
 *Dixon, E. M.
 *Dixon, William J.
 Dodd, A. W.
 *Dodson, J. E.
 *Dohrman, Frank S.
 *Donaldson, W. L.
 Donner, J. W.
 *Donner, Percy E.
 Donner, Robert
 Donner, W. H.
 *Donovan, W. F.
 *Doolittle, H.
 Dorman, A. D.
 *Dorman, P. O.
 Dorsey, G. D.
 Dougherty, J. W.
 *Douglas, E. P.
 Drake, Fred R.
 *Dripp, Harold
 Duane, James, Jr.
 DuBoise, Henry C.
 Duncan, J.
 *Duncan, T. S.
 Duncan, Wm. M.
 Dunn, William T.
 *Dutton, F. B.
 Dyer, Mr.
- F
- *Evans, B.
 *Evans, Lieut.
 *Evans, W. H.
 *Exstein, Henry L.
 Fagan, J. J. P.
 Faris, J. M.
 *Faris, Randolph
 *Farmer, Malcolm
 *Farrell, Charles L.
 Farrell, James A.
 *Farrell, J. J.
 Farrell, W. H.
 Fedder, W. P.
 *Filley, M. L.
 *Fillius, George T.
 Fisher, William G.
 Fitch, William H.
 *Fitzgerald, J. J.
 Fitzgerald, J. M.
 Fletcher, John F.
 Floersheim, Bert
 *Flynn, J. H.
 Foley, P. R.
 Follett, Louis
 *Foote, A. Giraud
 *Forbes, B. C.
 Forbes, W. A.
 *Force, C. W.
 Forrest, J. Dorsey
 Foster, Charles H.
 *Foster, H. M.
 Foster, James F.
 *Foster, W.
 *Foster, W. H.
 Fowler, A. A.
 France, James H.
 Francis, Lewis W.
 *Fraser, J. S.
 Frank, I. W.
 *Frazer, Fred
 *Frazier, Mr.
 Freeman, S. S.
 French, S. S.
 *Frerr, Walter
 Froment, Eugene McK.
 Fry, John A.
 Freyn, H. J.
 Fuller, J. W., Jr.
 *Fuller, M. L.
 *Fulton, Geo. E.
- G
- *Gable, H. C.
 *Galbraith, A. T.
 Galvin, J. E.
 Garry, A. H.
 *Garvey, Hugh J.
 Gary, E. H.
 Gault, C. E.
 Geesman, William

- George, Jerome R.
Gerry, Roland
Gerwig, F. H. N.
Gessler, Theodore
*Gillette, G. L.
*Gillmor, Horatio G.
Glass, Alex.
Glass, John
Gleason, W. P.
Glenn, Thomas K.
Goddard, H. W.
Goddard, John M.
*Gomber, W. J.
*Good, J. E.
Gordon, F. H.
Gould, Chas. A.
Gould, Frank
Grace, E. G.
Graff, E. D.
Grange, A. B.
Grayson, S. A.
Greenawalt, John E.
*Greene, J. W.
*Greenfield, Hugh
Gresham, W. B.
*Griffin, J. B.
Griffith, D. M.
Grose, James H.
Gruss, William J.
- H
Haggerty, H. G.
*Hair, H. F.
Hall, A. B.
Hall, Francis J.
Hamill, Laurence
Hamilton, Alex. K.
Hamilton, E. J.
Hamilton, J. W. H.
Hammond, James H.
*Hampson, R. R.
Hanlon, W. H.
Hanna, H. M., Jr.
Hardy, Francis H.
*Haring, Alex.
*Hastings, J. L.
*Hazen, W. E.
*Harrington, John T.
*Harris, Lloyd
*Harris, W. B.
Harrison, Edwin W.
Harrison, H. T.
Hart, Charles
Hart, John M.
*Harter, J.
*Hartmann, G. J.
Hatfield, Joshua A.
Havemeyer, John F.
*Hayman, E. J.
*Hays, W. C.
Hearne, William W.
- *Heaton, W. W.
Heedy, Henry W.
Heitmann, F. A.
*Henderson, C. T.
Hendricksen, J. J.
*Heneage, H. R.
*Heneage, Thomas
Henshaw, John O.
*Heppenheimer, Wm. C.
Herrmann, Charles E.
*Hewitt, D. F.
Heyward, Thomas R.
Hickok, C. N.
Higgins, W. B.
*Higgins, C. M.
Higgins, Harry E.
Hildrup, William T., Jr.
Hird, Roy G.
Hobbs, C. H.
Hobson, Robert
Hoerle, Frank D.
Hoffer, Allan
Hoffman, W. L.
*Hogg, Victor S.
Holbrook, P.
Holding, James C.
*Holliday, J. J.
Holliday, J. S.
Holmes, C. O.
*Homan, A. E.
*Hopkins, W. R.
Horner, W. S.
*Hosack, John P.
*Hough, D. L., Maj.
Hovey, Otis E.
Howard, John J.
*Howard, L. E.
Howell, Alfred C.
Howell, Herbert P.
*Howett, D. E.
Howland, H. P.
*Howland, S. W.
Hoyt, Elton, 2nd
Hubbard, C. H.
Hubbard, P. H.
Hudson, J. Banks
Hughes, Edward E.
*Hughes, E. P.
Hughes, H. L.
Hughes, I. Lamont
Hughes, John
Hughes, William H.
Hull, D. D.
Hulst, John
*Hunning, C. B.
*Hunnings, S.
Hunt, A. R.
Hunter, John A.
Hurd, Rukard
Hurlbert, William C.
*Hurlbert, William G., Jr.
- Hurd, Charles
Huston, A. F.
Hutchinson, O. N.
*Hutchinson, Lincoln
*Hoyt, Colgate
- I
*Igoe, A.
*Igoe, James
*Igoe, Peter
Irons, Robert H.
*Irving, Walter E.
Isham, Phillips
Ives, E. L.
- J
*Jackman, D. E.
James, Henry L.
Jameson, A. H.
Jay, John
*Jayne, Chester A.
*Jayne, D. W.
*Jennings, Edward J.
Jennings, Robert E.
Jewell, T. M.
*Johnson, Eads
Johnson, Frank H.
*Johnson, W. T. M.
Johnston, A.
Johnston, C. T.
*Johnston, J. W.
Jones, Evan F.
Jones, H. L.
Jones, J. M.
*Jones, J. O.
Jones, John E.
Jones, Lieut.
Jones, Richard, Jr.
Jones, William S.
Joseph, Eli
Joseph, Maurice
*Joy, Maurice
- K
Kauffman, Walter L.
Keefe, J. S.
Keller, A. T.
Keller, Carl Tilden
*Kelley, C. L.
Kennedy, Hugh
Kennedy, James B.
Kennedy, J. J.
Kennedy, Julian
Kennedy, T. W.
Kennedy, W.
*Kenzel, C. H.
Ker, Severn P.
Kerr, D. G.
*Kerr, W. W.
*Kiley, T. W.
*Kilmer, R. H.

*Kinkead, J. A.
 *Kinney, W. N.
 *Kinsel, T. F.
 *Kirkpatrick, H. B.
 Kiser, John W.
 Kittredge, J. P.
 Klaer, H. J.
 Klugh, B. G.
 Knisely, Ed. S.
 Knox, L. L.
 Knowles, A. S.
 Koch, H. J.
 Konold, Geo. F.
 Kranz, W. G.
 Kreps, J. E.
 *Krieg, Charles
 *Klein, L. C.
 *Kreutzberg, E. C.
 *Kroenke, A. J.
 Kuger, S.
 Kunhardt, W. B.
 *Kyle, W. T.

L

Lacey, H. R.
 Lanahan, Frank J.
 Langenbach, Ed.
 *LaPorte, C. W.
 Larkin, J. K.
 *Larkin, James J.
 Larsson, C. G. Emil
 Latty, S. D.
 Lavino, E. G.
 Lavino, E. J.
 Lea, Robert C.
 Ledoux, A. B.
 *Lee, H.
 Lee, Leif
 Leeds, W. S.
 Leet, George K.
 Lehman, Albert C.
 *Lehman, Chester H.
 *Leith, Dr. C. K.
 Lemoine, L. R.
 *Lenihan, Ernest P.
 *Leslie, Edward A.
 *Leventry, Roy
 *Lewis, Howard
 Lewis, R. A.
 *Lewis, Thomas A.
 *Lilly, J. T.
 *Lissberger, B.
 Lippincott, James
 *Lissberger, M.
 Little, Theodore W.
 *Littleton, Martin W.
 Lloyd, J. F.
 *Lockwood, Arthur J.
 Lomax, H. A.
 *Loughman, E. D.
 *Loughman, W. E.
 Lovejoy, Fred. B.

*Lowry, B. F.
 Lozier, Charles
 Lucey, J. F.
 Lukens, W. W.
 Lusk, Rollin W.
 Lynch, Edmund C.
 Lyman, Frank
 *Lyons, D. A.

M

*MacArthur, D.
 *MacDonald, Duncan
 MacDonald, D. C.
 MacDonald, Roy. A.
 MacIlvaine, F. S.
 McAlarney, J. H.
 McAteer, H. W.
 McBride, William
 McCaffrey, Thomas
 McCauley, J. E.
 McCleary, Elmer T.
 *McCleary, James T.
 McCloy, John H.
 McConnell, John
 *McCook, Willis F.
 *McCracken, F. T.
 *McCunn, J. M.
 McCurdy, William
 McDonald, Thomas
 McElhany, C. B.
 McFate, Wm. W.
 *McGrath, Wm. E.
 McGregor, Robert
 McIlravy, W. N.
 McIlvain, Edward M.
 McIntire, C. V.
 *McIntyre, W. W.
 *McIsaac, F. H.
 McKay, R. V.
 McKelvey, E. A.
 McLeod, John
 McMaster, Ross H.
 *McVey, G. K.
 *Mace, R. E.
 *Mackelson, H. A.
 *Macon, Mr.
 Manning, William E.
 *Mansfield, Edwin
 *Manville, Tracy F.
 Marchant, C. R.
 Mark, Clarence
 *Markowitz, A. Lincoln
 Marquard, F. F.
 Marseilles, W. P.
 Marshall, C. S.
 *Marshall, E. E.
 Martin, C. W.
 Mather, S. Livingston
 Mather, Samuel
 Mather, William G.
 Mathesius, Walther
 Mathews, John A.
 Mathias, David R.
 *Matlack, H. C.
 *Megeath, Samuel A.
 Meissner, C. A.
 *Meissner, Chas. H.
 *Meissner, Charles R.
 Menk, Charles A.
 Mercur, Robert J.
 Merriam, I. B., Jr.
 Merriman, D. A.
 Mesta, George
 Metcalf, Morris
 Meyers, F.
 *Michel, Raymond
 Miller, C. L.
 *Miller, L. H.
 *Miller, Wm.
 *Miller, W. G. A.
 Mills, James R.
 *Mitchell, Winthrop D.
 Mogan, C. J.
 *Mohr, G. K.
 Mohr, J. A.
 Moon, Geo. C.
 *Moore, Frederick C.
 Moore, H. G.
 Moore, H. R.
 *Moore, R. P.
 Moore, J. Turner
 Moore, M. G.
 Moore, Philip W.
 Moorhead, Mr.
 Morgan, Paul B.
 *Morgan, R. J.
 Morris, A. F.
 *Morris, D. McK.
 Morris, L. B.
 *Morris, W. W., Jr.
 Morris, Wm. J.
 Morse, A. C.
 *Morse, F. L.
 Moss, John B.
 *Mozier, M. L.
 Muchnic, Charles M.
 *Mulvey, J. E.
 *Mundle, A. C.
 *Murray, Andrew
 *Meyers, Wm. J.

N

Nash, A. L.
 Neeland, M. A.
 *Neide, W. Butler
 *Neimann, C. F.
 *Neven, John
 *Nevins, Thomas A.
 *Newcomb, A. G.
 Newsom, H. H.
 *Newman, R. K.
 *Newton, Edmund
 Nichols, J. A.
 Norris, G. L.
 *Norton, C. L.

*Nusbaum, Aaron E.
*Nutting, L. B.

O

O'Brien, H. N.
*Ochunhist, F. W., Jr.
*O'Gorman, Wm. D.
Ohl, Edwin N.
O'Neill, James L.
*Orbanowski, K. A.
*Overholt, A. C.
*O'Reilly, J. B.

P

*Page, J. J.
*Paine, George H.
Palmer, W. P.
Pargny, E. W.
Parker, Edward L.
Parker, J. Heber
*Parker, W. A.
Parsons, A. C.
*Parsons, A. E.
Pavitt, W. H.
*Paxson, Atwood
Pearce, William C.
Peckitt, Leonard
Peirce, Edwin H.
Pendleton, Joseph
Penton, John A.
Perkins, George W.
*Perkins, Walter G.
Perry, John E.
Pessano, Antonio C.
Peters, Edward V.
Peters, Richard, Jr.
Peterson, B. W.
*Peterson, Fred B.
Petinot, G. N.
Pettis, W. W.
*Pettit, Robert
*Pfau, Julius W.
Pfeiff, L.
*Phillips, F. Rees
Phillips, R. C.
*Phillips, Waldo L.
Phillips, W. Vernon
*Picinich, A. D.
Pierce, Talbot
*Pierce, W. J.
Pilling, George P.
Pilling, W. S.
*Pleasance, H. H.
Plummer, James
Pollock, Porter
Pond, C. P.
Porter, J. W.
Post, Andrew J.
Post, Robert C.
*Pratt, H. A.
Pratt, H. W.

Pratt, R. H.
Price, E. F.
*Purnell, Arthur
*Purnell, Frank

Q

Quarrie, B. D.

R

Rainey, Roy A.
Ramey, G. W.
Ramsburg, C. J.
*Ramsey, W. H.
Rand, Charles F.
*Ransome, A. W.
Rathbone, Richmond L.
*Rawle, James W.
Raymond, H. A.
*Rebman, Samuel
Rees, Charles Prescott
Reese, P. P.
Reeves, S. J.
*Reilley, J. J.
Reilley, E. J.
Reilly, W. C.
*Reimer, H. C.
Reynders, J. V. W.
*Rhodes, C. H.
*Rianhard, T. M.
Richards, Joseph W.
Riddle, L. E.
Ridgway, William H.
Ripperger, W. F.
Roberts, W. F.
Robinson, C. S.
*Robinson, J. R.
Robinson, Theodore
*Rodier, J. H. D.
Rogers, William A.
Rose, Geo. E.
*Ross, D. W.
Ruddiman, John
*Ruder, Wm. E.
*Rudolf, R. C.
*Ruhlander, Henry
Ruiloba, J. H.
Runyon, W. C., Jr.
*Rush, D. Fairfax B.
Rushmore, David B.
Russell, John, Jr.
Russell, N. F. S.
Rust, E. J. Lee
Rust, E. M.
Rust, H. B.
Rust, S. M.
Rust, W. F.
*Ryan, Allan A.
Ryan, Dan. J.
Ryerson, Joseph T.
Rys, C. F. W.

S

*Salter, H. B.
Samuel, Frank
Samuels, R. D.
Sargent, W. D.
Sattley, Elmer C.
*Savage, J. F.
Sawhill, E. P.
Scammell, M. J.
*Schaumberg, Otto
*Schiff, Isaac
Schiller, William B.
Schleiter, Walter F.
*Schmid, Martin
Shants, G. Theodore
Schonthal, D. C.
*Schwartz, L.
*Scott, Donald
Scott, George C.
*Scrymser, B. F.
*Sexsmith, George H.
Shepard, W. T.
*Sheridan, R. J.
*Sheriff, A. R.
*Sherman, C. W.
*Sherwin, John
*Shorham, C. W.
Short, G. W.
*Shotwell, Thomas C.
*Shrieber, Harry T.
Sias, John M.
Siebert, W. P.
Simonds, A. T.
*Simonson, Arthur
Singmaster, J. A.
Sinn, Francis P.
*Sinnott, W. C.
*Sites, F. R.
Skiles, R. C.
*Slee, F. C.
Slick, E. E.
Slick, F. F.
*Sloan, A. P., Jr.
*Sloane, Parker
*Sloane, Wm. Douglas
Smart, George
Smith, C. C.
*Smith, C. M.
*Smith, David H.
Smith, Floyd K.
*Smith, Geo. T.
*Smith, J. C.
Smith, James W.
Smith, Oberlein
*Smith, Pemberton
*Smith, R. T.
Snyder, Wm. P., Jr.
Snyder, H. S.
Souder, Harrison
*Spear, W. M.
Speller, F. N.

- *Spence, George
 *Spencer, Frank N.
 Spilsbury, H. G.
 *Sprague, D. J.
 Sproull, E. Theodore
 Stambaugh, John
 *Stanford, George I.
 Stansfield, Alfred
 Stanton, W. A.
 Stark, C. J.
 *Starkey, J. F.
 Starkey, W. P.
 *Starrett, Paul
 *Spilsbury, E. G.
 *Sparrows, L. K.
 *Stapleton, L. D.
 *Stear, E. J.
 Stearns, Edward B.
 Stebbins, Howard S.
 Steel, Chas C.
 Stephenson, B. S.
 Stephenson, James I.
 *Stevens, C. N.
 Stevens, Charles G.
 *Stevens, Oscar F.
 *Stevens, R. P.
 Stevenson, A. A.
 Stewart, Peter
 Stewart, Scott
 Stillman, J. S.
 *Stimpson, H. F.
 Stoddard, Harry G.
 *Stokes, Walter W.
 *Stone, C. B.
 Stone, C. F.
 Stone, E. E.
 *Story, Robert K.
 Stoughton, Bradley
 Stratton, W. H.
 *Strausbaugh, C. K.
 Sturtevant, Paul
 Suffern, E. S.
 Sullivan, G. M.
 Sullivan, Geo. R.
 Summers, Harry W.
 *Swaney, A. F.
 Swartz, Alfred H.
 Sweeney, M. J.
 Sykes, W.
- T
- Tangring, Olaf
 *Tate, R. H.
 Taylor, Knox
 Taylor, Wade A.
 *Taylor, Wm A.
 Taylor, W. Hethering-
 ton
 *Tener, Hampden E.
 *Tener, John K.
 *Terbell, J. B.
- Thayer, Rodney
 Thomas, Albert J.
 *Thomas, C. E.
 Thomas, Charles S.
 Thomas, E. P.
 Thomas, George, 3rd
 Thomas, Leon E.
 Thomas, T. E.
 Thomas, W. A.
 *Thomas, Wm. R., Jr.
 Thompson, A. W.
 *Thompson, John F.
 *Thompson, J. I.
 *Thompson, W. D.
 Thorp, G. G.
 Tickner, Frank W.
 *Tierney, J. T.
 Timmins, George
 Tod, Fred
 Todd, W. B.
 *Tomlinson, Silas M.
 Topping, John A.
 Towne, Thomas
 Trabold, Frank W.
 Tracy, David E.
 *Trainer, J. N.
 Trainer, W. B.
 Tripp, Chester D.
 *Tuft, J. P.
 *Turner, D. C.
- U
- Underwood, Lawrence
 Unger, J. S.
 Uphouse, Harry G.
 *Usher, H. L.
 Utley, S. W.
- V
- Valentine, S. G.
 *VanCott, Lincoln
 Vincent, Joseph E., Jr.
 Vogt, A. W.
 Vosmer, W. F.
- W
- Waddell, Jacob D.
 Wadsworth, J. E.
 *Wales, George R.
 Walker, W. R.
 Wallingford, B. A.
 *Walsh, Timothy
 Ward, J. H.
 Warner, George
 Warren, William H.
 Waterhouse, G. B.
 Watson, W. E.
 Watts, Geo.
 Wayland-Smith, Rich-
 ard
- Weaver, H. B.
 Webb, Albert R.
 Webster, William R.
 *Wegner, E. R.
 *Weigel, Frederick
 Weir, D. M.
 Weir, E. T.
 *Weisbrod, J. F.
 Weiss, Jay G.
 *Wells, J. Hollis
 Wells, R. G.
 Wendell, Carl A.
 West, Jas. G., Jr.
 *Whaley, A. R.
 Wharton, O. H.
 Wheeler, Seymour
 Whitaker, N. Price
 White, G. A.
 White, H. S.
 Whitehead, Geo. W.
 *Whitney, R. H.
 *Wholley, R. A.
 *Whyte, Geo. S.
 *Wigtel, Carl
 *Wilbur, J. Finch
 Wiley, Brent
 Wilkin, J. F.
 Willcox, F. H.
 Williams, Charles H.
 *Williams, E. M.
 Williams, H. D.
 *Williams, L. D.
 *Williams, R. L.
 *Williams, Ralph B.
 Wilputte, Louis
 *Winkworth, E. J.
 Winslow, F. A.
 *Winter, Emil
 Wolfe, William Lloyd
 Wolhaupter, Benjamin
 Wood, Alan D.
 Wood, Charles L.
 Wood, E. T.
 *Wood, F. D.
 Wood, H.
 Wood, R. G.
 Wood, Walter
 Woodard, L. A.
 Woods, John E.
 Woods, Leonard G.
 Wooldridge, William J.
 Wortham, Milford
 *Wray, Thomas
 *Wright, Albert
 Wright, Samson, D.
 Wright, W. L.
 *Wyatt, C. A.
- Y
- Yates, Harry
 Young, A. G.
 *Young, E. L.

